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Number 1

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SPECIAL FEATURES

THE DESIGN OF AIR TURBINES
THE TECHNICAL HISTORY OF THE AIRPLANE
SEAPLANE FLOAT CONSTRUCTION
AERIAL TRANSPORT AND TRAVEL
INTERNATIONAL AIRCRAFT STANDARDS

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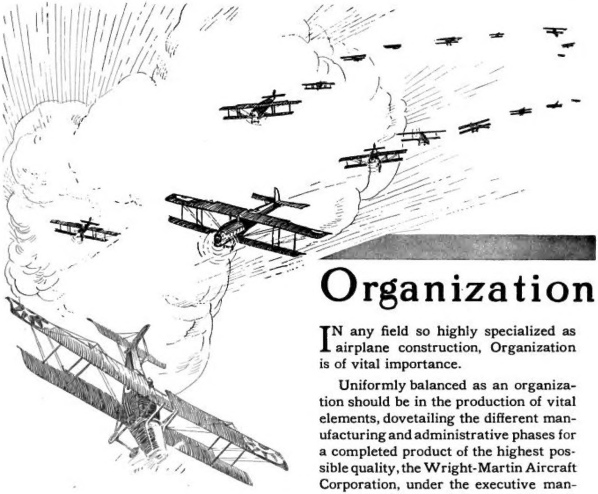

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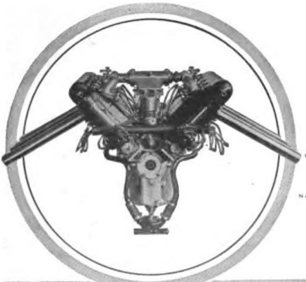

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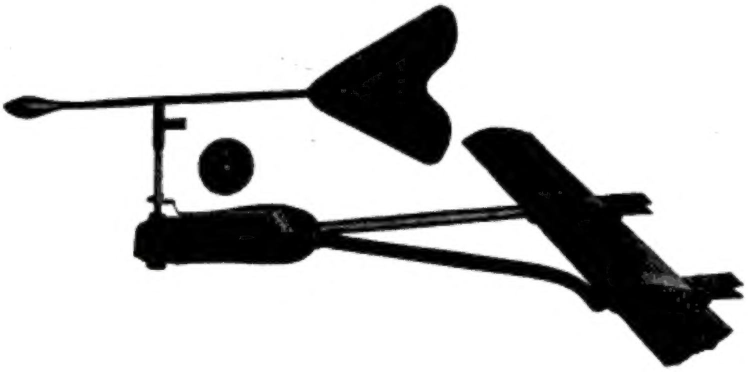

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Vol. IV February 1, 1918 No. 1

The Design of Air Turbines

By Alexander Klemin and Edward P. Warner

While air turbines have occasionally been used to pump gasoline from the main tank to an auxiliary, when it could feed by gravity, they were chosen for such purposes purely by a method of trial and error, and air turbine design did not really become important enough to warrant an attempt to establish it on scientific principles until the greatly extended use of radio apparatus, searchlights, stabilizer servomotors, etc., during the last few years, has made absolutely necessary the provision of satisfactory means, independent of the engine, for generating considerable quantities of electrical power.

There are three methods of treating the design of air turbines, only two of which will be considered here. First, it may be based on experiment, reinforced by laws of geometrical similitude, which we shall discuss somewhat later. Second, it may be based on windmill theory. This is little used now for any purpose; the standard works on the subject are out of print and difficult to obtain, and we shall make no attempt at a treatment of it in this place. The third method, and the one which, in the opinion of the authors, gives by far the most satisfactory results, involves an application of the Drzewiecki, or Lanchester, theory of propeller design.

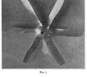

FIG. 1

We shall now proceed to a discussion of the methods of designing air turbines in accordance with propeller theory, with incidental mention of the chief modifying factors, the effect of which is as yet undetermined, and shall then carry through the design of a representative fan. Methods of constructing will also be taken up.

If we draw a section through the blade at any point, it is apparent that the motion of that section is the resultant of two easily-defined components. One of these is parallel to the fan axis, and is equal to V, the speed of translation, while the other is perpendicular to that axis and is equal to $2\pi rn$. We may then write $\tan A = \frac{2\pi rn}{V}$, where A is the angle between the resultant motion and the axis of the fan. Since V and n are the same for all portions of the blade, we see that A diminishes as r diminishes.

We may now treat each infinitesimal element of the blade as a wing section, and calculate the forces accordingly. In order to secure forces of the magnitude which may prove to be desirable, each blade element is set at an angle B with the line of resultant motion of the element. (See Fig. 2.)

The results of a wind tunnel test on a wing section are primarily expressed by two graphs, giving, respectively, the force coefficients parallel and perpendicular to the wind direction. In applying such results to air turbine work, we desire to re-resolve these forces into components parallel and perpendicular to the axis, the first being the thrust on the bearings and the "effective resistance," which must be overcome by the propeller of the airplane; the second being the force due to the given element available for driving a generator.

Fig. 3 shows the axes in question, L and D being the forces on the element expressed in the conventional laboratory manner, T and Q those obtained by resolution.

It is immediately evident that:

$$T = L \sin A + D \cos A \qquad (1)$$

$$Q = L \cos A - D \sin A \qquad (2)$$

$$\text{Torque} = Qr = (L \cos A - D \sin A)r \qquad (3)$$

$$\text{Let } \cot \gamma = \frac{L}{D}$$

$$\text{Then } \sin \gamma = \frac{D}{\sqrt{L^2 + D^2}}$$

$$\cos \gamma = \frac{L}{\sqrt{L^2 + D^2}}$$

Simplifying (1), we have $T = \sqrt{L^2 + D^2}(\cos \gamma \sin A + \sin \gamma \cos A) = \sqrt{L^2 + D^2} \times \sin (A + \gamma) = L \times \frac{\sin (A + \gamma)}{\cos \gamma}$.

Cos γ differs from 1 by less than ½ per cent over the larger portion of the blade, and we may, therefore, write, without serious error: $T = L \sin (A + \gamma)$.

(3), similarly, reduces to: Torque $= \sqrt{L^2 + D^2} \times r(\cos\gamma \cos A - \sin\gamma \sin A)$. Ignoring, as before, the small quantity $(\sqrt{L^2 + D^2} - L)$, we have: Torque $= L \times r \times \cos(A + \gamma)$.

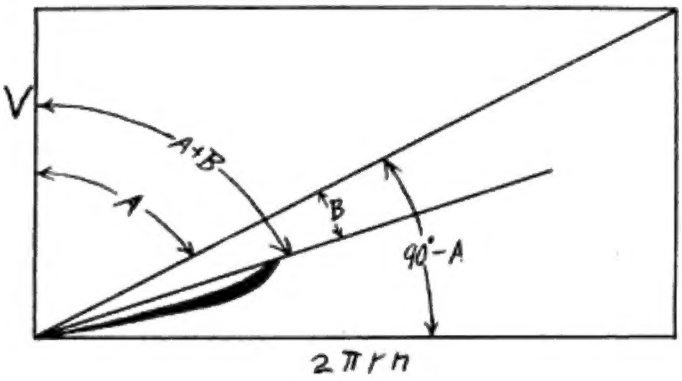

Fig. 2

The useful work done by the element is then: $P = 2\pi rnQ = 2\pi rnL\cos(A + \gamma)$, and the power which must be furnished at the airplane propeller to overcome its resistance is: $R \times V \times L \times \sin(A + \gamma)$. The efficiency of the element is then: $\dfrac{2rn\pi L\cos(A+\gamma)}{VL\sin(A+\gamma)} = \dfrac{\tan A}{\tan(A+\gamma)}$.

In attacking the actual design of an air turbine, we first decide on a diameter and blade form to be employed. Considerable latitude in these points is permissible, and it is generally possible, after a little experience, to guess them closely enough at the first trial. Several stations, from four to eight in number, are then placed at approximately equal intervals along the blade, and the section to be used at each is selected. These sections should be of such a nature as to give at least a fairly high L/D, and should resemble each other in general outline, although becoming thicker as the hub is approached.

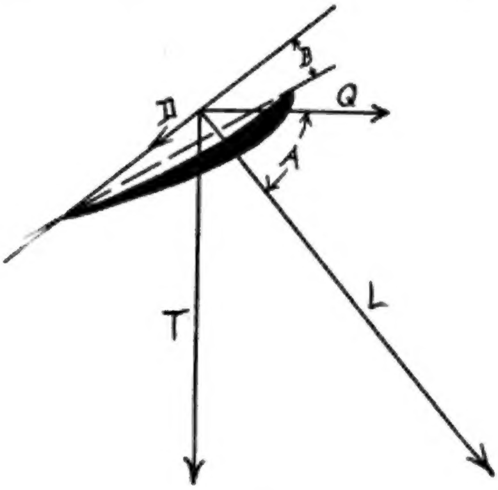

Fig. 3

The lift per running foot and the efficiency at each station are then determined, the lift being $K_y bV_r^2$, where K_y is the lift coefficient from a laboratory test, b the width of blade, and V_r the resultant velocity through the air, V_r^2 being equal to $V^2 + (2\pi rn)^2$. Having L, the torque and thrust per running foot at each point can be determined from the expressions: $L \times r \times \cos(A + \gamma)$ and $L \times \sin(A + \gamma)$.

The next step is to plot a torque grading curve and thrust grading curve, the abscissae of these curves representing the radial distance from the propeller axis to the station, their ordinates the torque and thrust per running foot, respectively. The areas under these curves then represent the torque and thrust for the entire blade, and furnish the data for computing the power developed and the resistance opposed by the turbine to the advance of the machine.

Since the power required is ordinarily known in advance, it is customary to write the blade width at each station as a function of k, an unknown. We can then, after the completion of the graphical integration of the curves, solve for a value of k which will give exactly the necessary torque, thereby avoiding an application of cut-and-dry methods.

An alternative method of procedure is to draw curves of torque and $\dfrac{\text{torque}}{\text{efficiency}}$, the latter quantity being readily convertible into thrust.

Having given this brief exposition of the method, we shall summarize the design of an actual air turbine. The assumed conditions are: a speed of translation of 65 m.p.h., a rotative speed of 3600 r.p.m., and a required power of 825 watts. We shall try at six-bladed fan 14 in. in diameter. A table may then be drawn up as follows:

Station No.	Rad. (ins.)	$2\pi rn$	A	Blade width	$(2\pi rn)^2$	$V_r^2 = (2\pi rn)^2 + V^2$	B (Angle of incidence)
1	6	188.5	63°15′	.98 k	35500	44500	6°
2	5	157.1	58°50′	k	24600	33600	6°
3	3½	110.0	49°10′	.98 k	12100	21100	6°
4	2	62.8	33°30′	.92 k	3950	13000	6°

We shall use Eiffel's propeller sections Nos. 61, 60, 59 and 31 for the four elements. These sections, due to the considerable camber of the lower face, give a large lift coefficient, thereby making it easy to secure the required power with the relatively small diameter proposed. From the experimental data given for these sections, we find K_y and K_x at 6°, continuing our table as below:

Station No.	K_y	$R\left(=\dfrac{K_y bV_r^2}{144}\right)$	$\dfrac{L}{D} = \cot\gamma$	γ	$Q = R \times \dfrac{r}{12} \times \cos(A+\gamma)$	$T[=R\sin A+\gamma]$
1	.00112	.340 k	12.3	4°39′	.064 k	.315 k
2	.00114	.266 k	10.4	5°30′	.048 k	.240 k
3	.00120	.172 k	9.2	6°12′	.028 k	.141 k
4	.00090	.075 k	5.9	9°37′	.009 k	.051 k

R, Q and T, in the above, are expressed as lbs. (or lbs. ft.) per running in. of blade, and k is the maximum blade width in ins.

We now plot curves of Q and T in Fig. 4. The former only is shown to avoid confusion. The area under the Q curve is found to be 43.2 squares, corresponding to a torque of .216 k lbs. ft., and the area under the T curve corresponds to a thrust of 1.05 k lbs.

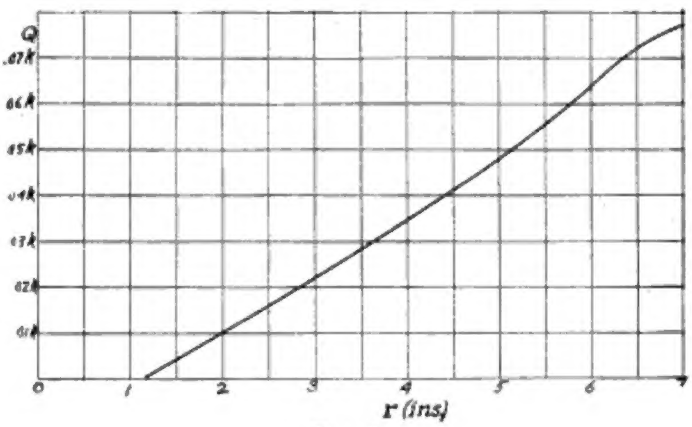

Fig. 4

It is desired to generate, as previously specified, 825 watts, and this is equal to 609 ft. lbs. per sec. Then, $2\pi Qn = 609$, and $Q = 1.613$ lbs. ft., n being 60 revs. per sec. Dividing the total torque required by the number of blades, we see that the torque due to each blade must be 0.269 lbs. ft. Since the graphical integration just performed shows us that this torque is equal to 0.216 k lbs. ft., we may equate the two expressions, and k is then 1.25 ins. The width of each blade element may then be obtained by substituting this value for k in the column of the design computations.

Substituting for k in the expression for thrust, and multiplying by the number of blades, we find that the presence of the air turbine adds 7.9 lbs. to the total head resistance of the air turbine. The work done in driving it through the air is then equal to the resistance times the speed, or 750 ft. lbs. per sec., and the efficiency is 81 per cent.

Since, however, the power driving the turbine ahead must first be transmitted through the propeller, and since the efficiency of the propeller is likely to be about 75 per cent, the overall efficiency of the air turbine as a generating device is equal to the product of these two quantities, or, roughly, 60 per cent. Although this appears rather low, the power consumed is so small in comparison with the total power of the engine that the slight loss is more than compensated for by having the generator function at all times, whether or not the engine is running, and by the avoidance of additional trains of gears driven by the crankshaft.

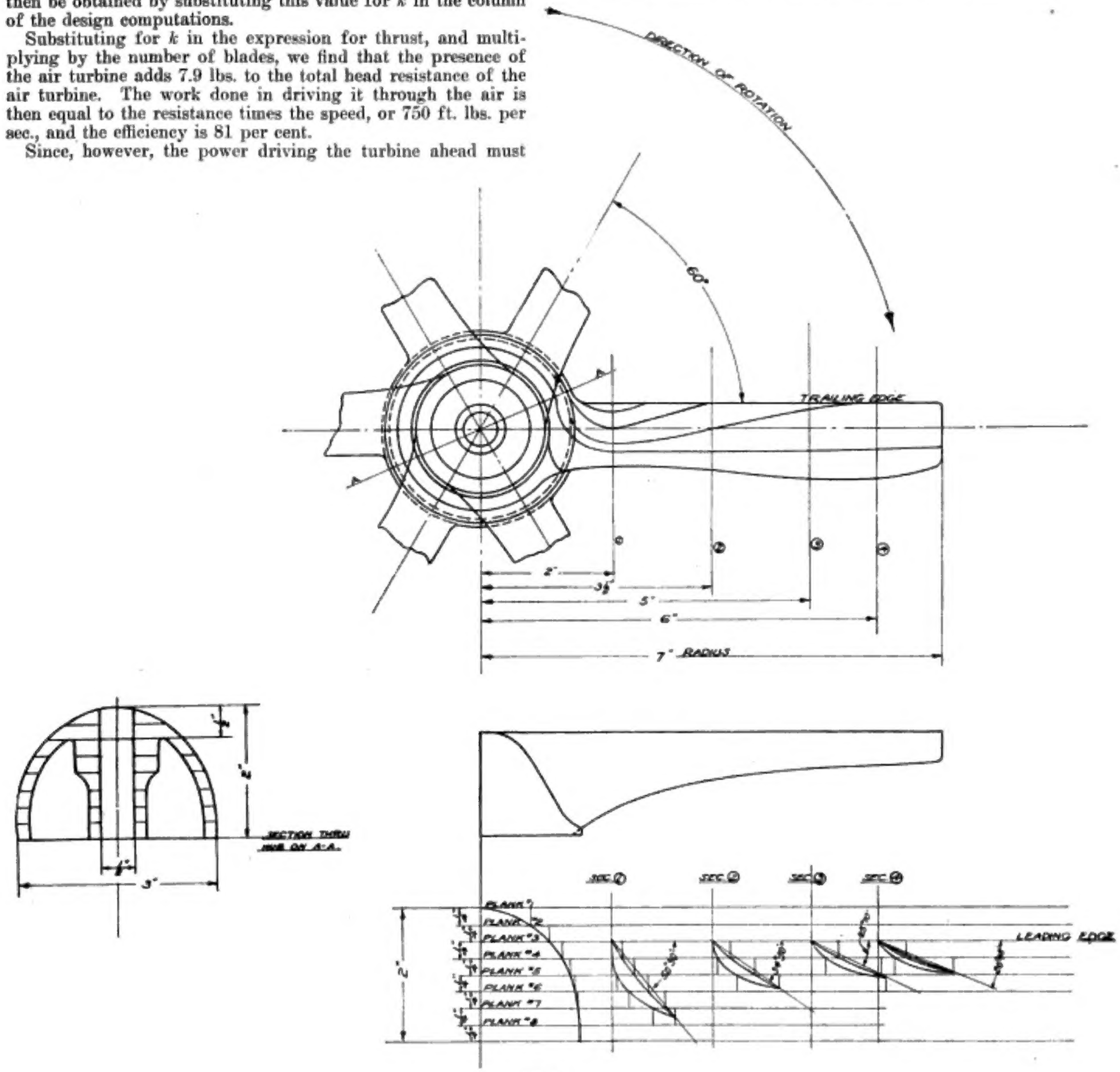

Fig. 5

A drawing of this turbine is shown in Fig. 5, and a photograph in Fig. 1. The sections and contours are faired in the same way as for an air propeller, although less care is needed than in propeller drawing, and it will not be necessary to treat the method of layout.

Until the performance of further experimental work, it is almost impossible to say anything definite about the effects of interference due to objects close behind the fan. Since the effect of the blade elements is to create a partial vacuum above their upper surfaces (i.e., behind the turbine), while the effect of any body placed in a wind, and especially a body not of low-resistance form, is to "bank up the air" in front of it, creating a positive pressure, it is evident that these two tendencies will oppose each other, and that there will be some loss of power and efficiency as a result, but a quantitative determination of these losses by analytical methods would be a hopeless task.

The nature of the flow about the blades of an air turbine has not been fully determined. Since work is done by the system, energy must be withdrawn from the air, and it is probable that there is a certain diminution of speed of the air approaching the turbine before it actually impinges on the blades —a phenomenon analogous to the indraught of an air propeller.

If it be desired to find the work done and efficiency under other conditions, when the speed of rotation, or the speed of advance, or both, are varied, the procedure is that already carried out, save that the angle $(A + B)$ has now been fixed, and

B must, therefore, be obtained by subtraction, instead of being arbitrarily chosen. If the speed of rotation be increased, *A* will increase, and *B* will consequently decrease. The lift coefficient will become smaller, but the resultant velocity of each element will increase, and the counteraction of these two factors will result in giving a torque curve having a maximum at a comparatively low rate of rotation. The maximum useful work will occur at a considerably higher speed, as this quantity for equal torques is directly proportional to the rotational velocity, and the maximum efficiency will correspond to a still higher value. (See Fig. 6.)

An increase in the speed of advance, on the other hand, always results in an increase of torque and useful work within reasonable practical limits, as the increased resultant velocity and increased angle of incidence *B* here work together, instead of opposing each other. The efficiency curve, however, has a maximum at a moderate speed, beyond which point it begins to drop off with increasing speed of advance. (See Fig. 7.)

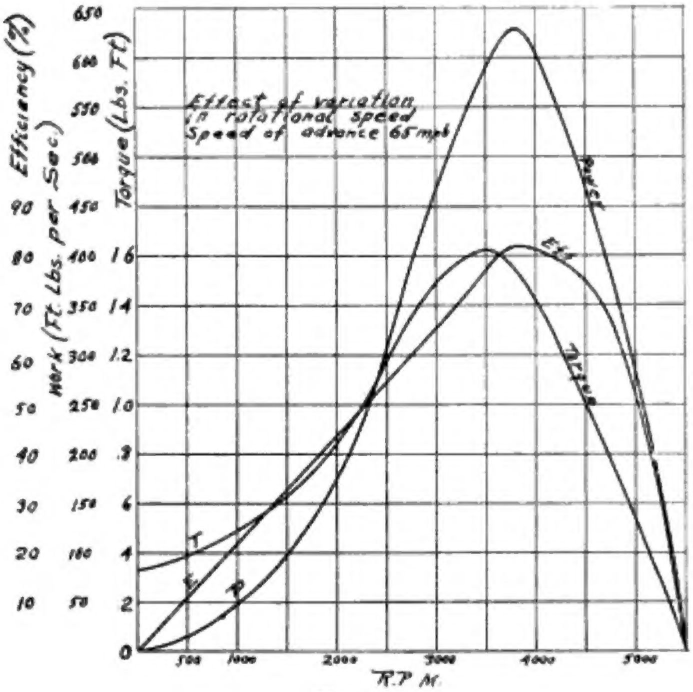

FIG. 6

An inspection of Fig. 6 shows that if the air turbine be so designed as to give nearly the maximum torque available for one of that size when operating under normal conditions, the torque curve in that vicinity will be very nearly horizontal, and a slight variation in torque will bring about a large change in speed. The regulation of the generator is therefore likely to be bad, and the apparatus may show itself prone to "hunt." This may be largely avoided, and without any serious loss of efficiency, if the elements be arranged to work at a smaller angle of incidence, so that normal conditions will correspond to a point on the negatively-sloping portion of the torque curve.

Turbines may be tested in a wind tunnel while actually driving a generator, and the torque, thrust, work and efficiency at various wind and rotational speeds may be actually determined. The work of this sort done thus far is scanty and unsatisfactory, but what there is of it seems to indicate a good accord between theoretical and actual results.

At the beginning of this paper it was remarked that empirical results may be extended to other similar cases by the direct application of simple formulae, and we shall now discuss this method of procedure. It is evident that, for geometrically similar turbines operating at the same rotational speed, and at speeds of advance directly proportional to the diameters, the torque is proportional to the fifth power of the diameter, since the blade area varies as the square of a linear dimension, and the resultant velocity of the element along its path, to the square of which the air force is proportional, varies directly as the diameter. It follows that the useful work done is proportional to the fifth power of the diameter, and that the efficiency remains unaffected.

For the more common case in which speed of advance remains constant and the rotational speed is inversely proportional to the diameter, the torque rises with the square of the diameter. When neither speed changes strict similarity cannot be maintained; but it will be found that the torque varies very nearly as the fourth power of the diameter. If small changes in power be desired they can be secured by a modification of the blade width, to which the work done is very nearly proportional.

It can readily be demonstrated, by differentiating the expression for efficiency with respect to γ, that the efficiency of any given element at a fixed angle of attack is a maximum when $A = 45° - \frac{\gamma}{2}$. Since *A* varies with every section, it is necessary to adopt a compromise position for the point of greatest efficiency, and this position should be roughly coincident with the centroid of the torque grading curve, or about ¾ of the way out from the hub to the tip of the blade. In the case of the turbine, which we have been through the computations for, *A* is too large for best results, and a higher efficiency would have been secured if it had been possible to run at a somewhat lower speed (2200 r.p.m. for the very best results).

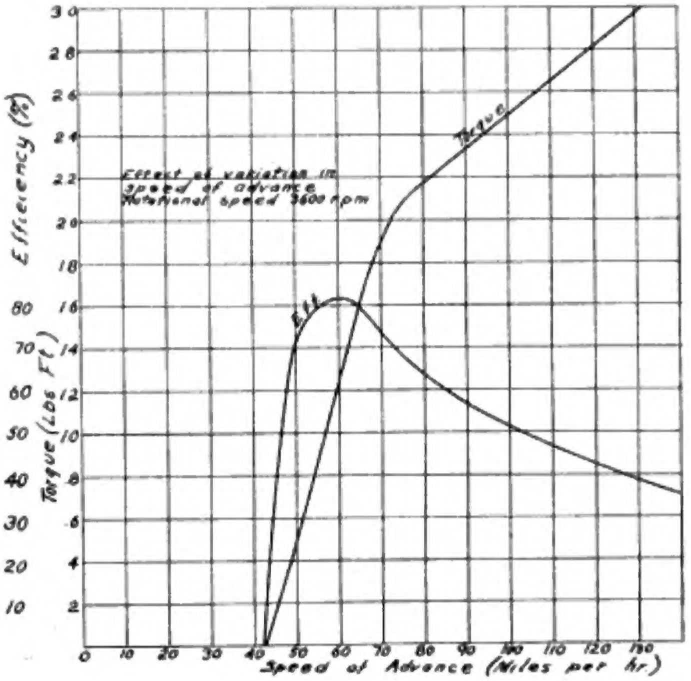

FIG. 7

The constructors of air turbines are divided into two schools, using, respectively, wood and metal. The first method calls for no especial comment, being a direct adaptation from propeller construction. Laminations are sawed out from thin sheets of some suitable wood (usually mahogany or walnut) and glued together, and the blades are then finished by hand until they check properly with their templates.

The metal employed for the second class is some aluminum alloy, different manufacturers and foundries using different formulae. Turbines may be cast in sand molds from a wooden pattern in the usual fashion. This, however, entails the serious disadvantage that it is almost impossible to get the blades identical and set at the same angle, especially in four- or six-bladed patterns, without a prohibitive expenditure of time and the employment of pattern-makers of an exceptionally high order of skill.

A more satisfactory method, which seems to give uniformly good results, is the making of a wooden pattern for a single blade, and as large a wedge of the hub as naturally pertains thereto. From this pattern are made as many castings as the turbine has blades, and the various parts, after being carefully finished and gaged, are screwed or soldered together. This subsidiary metal pattern is made of brass or iron.

Propeller casting is a tricky task at best, and only the most expert of molders are able to withdraw the pattern and smooth down the sand in such a fashion that the casting will not be unduly liable to flaws, and will be a close reproduction of the original.

The Technical History of the Airplane*

By Capt. F. M. Green, A.F.Ae.S., A.M.I.C.E.

The history and development of mechanical flight may be confined almost entirely to the present century. In the last century some success had been achieved in gliding flight, model airplanes had been made and flown, and at least two man-carrying airplanes had actually left the ground, but it was not until the year 1903 that the Wright Bros., having ended a painstaking research in gliding flight, earned for themselves the honor of being the first men to fly.

Directly the success of the Wright Bros. became known, or rather when people began to believe that what the Wright Bros. claimed was actually true, the development of flying became rapid in the extreme. To-day one is tempted to wonder why it was that it had taken man so many centuries of civilization to do what now seems to most of us rather an ordinary thing. We can call to mind nothing in the nature of an invention, nothing new in first principles. We hear of flights from Turin to London, of airplanes that carry loads that are measured in tons, we know that flying is common at heights of four miles or more, where the air is less than half its usual density. When we hear of these things it seems as unbelievable to us now that until fifteen years ago no one had flown for half a mile carrying just his own weight as it seemed unbelievable to us fifteen years ago that we should ever fly at all.

The chief reason why the development has been so rapid is undoubtedly that, until an airplane had been made to fly at all, experimenting on full scale was impossible. It reminds us of the advice of the old lady to her grandson, "Don't go near the water until you have learned to swim." Directly mechanical flight was possible, full-scale experiments were carried out, often at the risk of the life of the experimenter, and the more obvious problems became apparent. All the skill of the engineer and all the resources of science were called in to solve the problems as they occurred, until in the short space of fourteen years our scientific knowledge of aeronautics compares very favorably with the world-old science of navigation of the sea.

It is the intention of this paper to discuss the progress that has been made in dynamic flight, and to consider the chief factors that have made this progress possible. An attempt will be made to state in a general way the standard of development as it exists to-day, and to consider the possible direction of progress in the future.

Types of Machines

The flying machine is an apparatus in which an arrangement of surfaces is moved in such a way that the reaction of the air provides a vertical component of the force on the surfaces equal to the weight of the apparatus. An airplane, as we know it, has its supporting surfaces fixed relative to itself and is driven forward by the reaction of one or more airscrews.

Besides an airplane, two other sorts of flying machines have offered possibilities to the inventor. One is known as the Helicopter, in which the lifting surfaces are revolved in a horizontal plane. The second is called an Ornithopter, and in this the supporting surfaces are moved in a way to imitate a bird flapping its wings. Although both these types are conceivably possible, their usefulness and practicability appear doubtful, and it is only proposed in this paper to consider the airplane as we know it.

Airplane Performance

At the beginning of flying, the mere fact that an airplane left the ground at all was considered sufficient proof of its excellence. Nowadays we make careful measurements of the characteristics of each new airplane at various heights, and the word "performance" is used to refer to the speed, rate of climb, and load carried. A good performance is one of the important essentials of usefulness of an airplane, and we will now consider the factors that have enabled us to improve so much on the early airplanes.

There are four main factors that govern the performance of an airplane. They are:

1 The wing surface that supports the weight
2 The total weight supported in flight
3 The resistance of the airplane to forward motion
4 The thrust available from the airscrew or airscrews

These factors are very intimately connected, and each in turn will be considered, its effects discussed, and the possibility of improvement outlined.

Supporting Surface

Considering the first factor, the wings, it is necessary to know how to express the value of any particular arrangement of surfaces. The result at which to aim is to obtain the maximum vertical reaction or lift for the minimum horizontal reaction or drag. The term lift drag ratio is, therefore, a measure of the effectiveness of a plane. Another attribute is, however, desirable, viz., that the lift per square foot of plane shall be high, so that as little surface as possible need be used for a given minimum speed of flight.

Planes vary in curve, plan form, and arrangement and number of surfaces. The designer will vary these factors according to the sort of airplane he wishes to make.

Wing Section

The Wright Bros, did not know if they would be able to fly at all. They choose deeply cambered wing sections so that the maximum lift could be obtained at the minimum speed. The lift drag ratio of their planes was probably about 12 to 1, very much better than still earlier experimenters could obtain with flat planes. Present-day wing sections enable us to get a lift drag ratio of 17 to 18, while model tests have shown as good a ratio as 23.

This has been done at some sacrifice of maximum lift coefficient, that is to say, for a given minimum speed we need more surface to support a given weight than with a more cambered plane with a worse lift drag ratio. It would be an advantage if we could vary the camber of a plane to suit the speed, and many attempts to do this on an airplane in flight have been made. Unfortunately, apart from increased complication, the increased weight is likely to cause greater loss than gain.

Shortly before the war an experimental airplane was made at the Royal Aircraft Factory, which was fitted with wing flaps nearly the whole length of the plane. These flaps could either be turned down for low speed, or up for high speed, or they could be used differentially for balancing. It was in fact rather a crude way of varying camber. Although it achieved the distinction of being possibly the fastest airplane of the day, it was eventually considered that the extra weight and complication did not justify the device.

From many considerations it appears that much improvement in lift drag ratio is unlikely, but when the speed of airplanes becomes very much greater than it is to-day, it is quite possible that some device for changing the section of a plane during flight will be found necessary to obtain a reasonably slow landing speed.

Plan Form

Planes are generally made nearly rectangular in plan but with the ends more or less rounded. The ratio of span to chord is called aspect ratio and the higher this is made the better will be the lift drag ratio. Here again it is necessary to compromise, as the bigger the span of the airplane the heavier will be the wings, the greater the resistance of the necessary bracing and the rapidity of the manœuvring of the whole airplane will be decreased. From practical consideration, therefore, the aspect ratio of an airplane is generally from 5 to 8; recently some large airplanes have gone considerably beyond this figure, but it is very doubtful if anything has been gained.

Little is known as to the effect of using planes other than roughly rectangular, but it is not very likely that much improvement will be found with planes of other shapes.

Arrangement of Surfaces

The original airplane of the Wright Bros. was a biplane, consisting of two planes separated by about the width of the chord. Shortly after, monoplanes, triplanes and quadruplanes were made and flown. It is fairly certain that the most efficient plane is the monoplane, for there is no possibility of interference of the planes as there is on the multiplane. A biplane, however, is probably only a little worse than the monoplane, while a triplane is a little worse than a biplane, and so on. Structurally, the biplane is very much easier to make than the monoplane and, owing to this, the biplane construction has been almost universally adopted. Triplanes and quadruplanes have not had very much success, although it is quite possible that for very large airplanes the advantages gained in construction may outweigh the disadvantages of their somewhat low effectiveness.

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* Paper read before the Aeronautical Society of Great Britain.

From time to time suggestions have also been made that the amount of wing surfaces should be varied. This again is a complicated thing to do, and with modern wing sections there is practically never any gain in reducing wing surfaces; in fact, most airplanes would fly faster and not slower by having more surface if such surface could be introduced without extra weight or external resistance. This applies particularly to flying at heights.

Weight

The total weight that is carried on an airplane is obviously all-important, and it will, therefore, be useful to see what prospects we have of decreasing weight of airplanes of any given type. We will divide the airplane into the following components:

- Useful load
- Motor unit
- Fuel, oil and tanks
- Remainder, being airplane parts proper

The object of the airplane flying at all is, of course, to carry a useful load for a certain distance. In this load we do not include fuel and oil, and as the tanks vary in weight with the amount that has to be carried, it is convenient to include in the fuel and oil the weight of the necessary tanks and pipes.

For the purpose of general analysis it is assumed that the motors consume the same amount of petrol per b.hp. per hour, and the figure, 0.7 lb. per hp. hour, is sufficiently accurate to cover the weight of fuel, oil, tanks, and pipes. There are, of course, engines which do better than this, and many which do considerably worse. It is, however, a fairly good average for motors as they are now.

Analyzing a number of airplanes that have been used under active service conditions it has been found that, apart from the useful load, the motor unit, and the petrol, oil and tanks—the remainder representing the airplane proper—is very nearly one-third of the whole weight—32 per cent being rather nearer. This weight includes the wing structure complete, the body complete with its fairing, floor, seats, controls, instruments, etc., the tail plane, elevator, rudder and fin, and the landing gear and tail skid. This weight is on the average made up as follows:

	Percentage of airplane parts Per cent.	Of total weight Per cent.
Wing structure complete	41	13
Body complete	41	13
Tail plane, elevator, rudder and fin	6	2
Landing gear	12	4

If we take 32 per cent as the weight of the airplane proper we have the balance of 68 per cent to divide up among the motor unit and its fuel and the useful load. Various diagrams were then shown depicting the combined weight per hp. of the motor unit with its fuel, oil and tanks for various times of flight.

We have now only to decide what percentage of useful load we shall carry, and for what time it is to be carried, and we can find at once the weight per hp. of the complete machine.

Possibilities of Reduction of Weight

The weights of the airplane parts have now been fined down to a considerable extent, and, except for the use of newer materials, progress in saving weight is not likely to be very pronounced. Undoubtedly as time goes on we shall learn to make equally strong structures for less weight, and the development of aluminum alloys and pressed metal construction may help to a marked extent. At the present moment wood is used very largely in the construction of both the bodies and wings. To a great extent this is due to war urgency, and no doubt airplanes of the future will be made of more durable materials.

The chief particular in which it is probable that weight will be reduced is in the weight per hp. of the motor. Although progress in this respect has been remarkable, it is probable that we have not nearly reached the limit of weight in internal combustion motors. At the present day the complete motor unit—*i.e.*, the motor itself, the airscrew, water and radiator if water-cooled, exhaust pipes, and so on—weighs generally from 3 to 4 lb. per hp. Certain very light motors have been made in which the weight is very little more than 2 lb. per hp. It is quite conceivable that in the next few years motor units of 1½ lb. per hp. will be available, and in all possibility with the improvement in material will enable us to make motor units weighing not more than 1 lb. per hp. in the more distant future.

With regard to fuel consumption the best petrol motors have a brake thermal of efficiency of about 30 per cent. It may be this will be improved, and here again saving of weight may be effected.

The only motive power used to-day is supplied by internal combustion engines. Some day no doubt a lighter form of motive power will be developed, and it is in this respect that the most startling progress may be expected.

Resistance of the Airplane to Forward Movement

The resistance of the airplane is made up of two factors. The first is the resistance of the main planes. The second item is made up of the resistance of the body, the struts, wires and fittings of the wings, the landing gear, tail plane, rudder, and so forth. These can all be grouped together under the general term of body resistance. It is in respect to the reduction of this resistance more than anything else that the modern day airplane owes its superiority over that of the original Wright machine.

The first man who seems to have understood the importance of reduction of resistance was the late Edouard Nieuport, who in 1909 produced an airplane with a very fat body which almost completely enclosed the pilot and succeeded in making a big improvement in speed on an airplane of comparatively small power. Since that day all modern airplanes have bodies which are enclosed as completely as the requirements of the pilot's view allows.

Details of Resistance

The resistance of the external parts of the airplane has now been fined down to a considerable extent; modern day airplanes do not differ very much in this respect. The various components of the airplane will generally be found to have the following proportional resistances:

	Per cent.
Body	62
Landing gear	16
Tail plane, fin, rudder and elevator	7
Wires, struts, and fittings of the wing structure	15

It will be noted that by far the larger part of this resistance is made up of the body itself. A large part of the body resistance, however, is really used in providing cooling for the engine, whether it is an air-cooled or water-cooled engine. Whether the radiator is let into the body or is external to it does not appear to make a great deal of difference. The body is also of greater resistance than it need be, as it is necessary that the pilot shall have a good view and shall not be entirely enclosed. Bodies round in section are somewhat lower in resistance than the square bodies, but the difficulties of manufacture generally make their use undesirable. It is not likely that we shall be able to reduce the body resistance to a very great extent unless we can use a motor which does not require external cooling. It is true that it would be possible to use the complete surface of the body or of the wings as a radiator and by this means the waste of power would be negligible, but in order to do this the radiator becomes an impracticable and heavy piece of apparatus.

The resistance of the landing gear is considerable and it is difficult to see how this can be very much reduced. It has been suggested by many people that the landing gear could be stowed away inside the body while the airplane is in flight, and no doubt in the future this may be done. It is, however, very difficult to design a folding landing gear without an undue sacrifice of weight or a large increase in the cross section of the body.

Another factor which influences the resistance of the airplane to a considerable extent is the increased resistance of the parts of the airplane that are in the slip stream of the airscrew. The allowance to be made for this is not known very definitely, as in either a tractor or pusher airplane the resistance of the body itself tends to increase the efficiency of the airscrew.

Thrust Available for Flight

The thrust available from the airscrew varies directly as the horsepower of the motor, directly as the airscrew efficiency, and inversely as the forward speed of the airplane. If the efficiency is constant the thrust available at any speed will depend upon the horsepower of the motor, consequently the weight per hp. of the whole airplane is an expression for the ratio of thrust to weight of airplane. I have referred to a general method for obtaining the proportional weight per hp. of an airplane knowing the weight per hp. of the motor, the number of hours of flight, and the percentage of useful load that has to be carried. As in practice the efficiency of the airscrew does not vary much, and as the resistance of modern day airplanes per lb. of weight is fairly similar, it is possible to predict rather roughly the performance of the airplane simply from the weight per hp. figure.

Airscrew Efficiency

We have said that airscrew efficiency does not vary much in practice. There is, however, a considerable difference between the best attainable efficiency and that obtained under certain conditions.

As Lanchester has shown in Aerodynamics, for maximum airscrew efficiency the pitch must be a little greater than the diameter. From first principles also it is easy to see that the diameter must be a certain minimum so that the loss in the slip stream shall be small. Now it is always convenient to have an airscrew as small as possible, for when it is smaller it will be lighter and less in the way.

Again, unlike the screw of a ship, the airscrew has to work at bigger thrusts when the airplane is going slow and climbing than when it is going at full speed on the level. As a consequence the airscrew of a modern airplane nearly always has its maximum efficiency when its effective pitch is at its largest —*i.e.*, when it is going fast, and its efficiency is lowest when the pitch is small, that is, when the airplane is climbing.

Another disadvantage when the airplane is climbing is that the engine is more heavily loaded, and in consequence the airscrew goes slower. With engines as they are, this always means less horsepower. We need, therefore, either a change speed gear or an airscrew in which the angle of the blades can be changed. This will avoid a drop in horsepower, and to a lesser extent the loss of efficiency when climbing. We also need, however, a propeller of varying diameter so that combined with a change of angle and a suitable engine speed we should get nearly a maximum efficiency under all conditions.

There is not much room for improvement in airscrew efficiency working under the best conditions, as the efficiency is as high as 85 per cent. When climbing, however, the efficiency will frequently drop to less than 65 per cent.

Attempts at variable pitch or variable angle airscrews have been made, but none seem to have reached a practicable stage. The design of such a screw is quite possible, and no particular invention is required to make it a success. As the demand undoubtedly exists, variable pitch airscrews will be made successfully, and will become a standard part of the airplane equipment in the near future in all probability.

Performances of the Future

The airplane flown by the Wright Bros. had a speed of 30 to 35 miles per hour, and we have in a few years made airplanes that fly four times as fast. What then are the prospects of the future?

Before considering this we must consider the effect of height on the speed at which an airplane flies.

Very briefly the resistance of the airplane and the horsepower of the engine each fall off when the density of the air decreases, but with engines as now designed the horsepower falls off faster than the resistance.

It is now proposed to consider what speed we are likely to attain in an airplane of the future flying at a height of 10,000 feet. As it is a hypothetical airplane engine, we are entitled to assume that all the improvements outlined in the preceeding paragraph are incorporated into it. The assumptions we will make are:

(*a*) That the planes have variable camber.

(*b*) That the motor unit weighs 2 lbs. per hp., and will maintain this horsepower at all heights up to 10,000 feet.

(*c*) That the body is the best possible shape, completely enclosed with no external fittings.

(*d*) That the landing gear shall be folded inside the body during flight.

(*e*) That the airscrew efficiency shall be 85 per cent.

(*f*) That the percentage of useful load carried shall be 15 per cent.

(*g*) That the duration of the flight shall be two hours.

Assuming that the weight of the structure is as at present, the weight per h.p. of the complete airplane will be 6.4 lbs. As we are considering a faster airplane than is at present made it may be as well to allow a little more weight for the airplane structure, and we will assume that the weight per hp. is 7 lbs.

We will now turn the percentage weights into pounds by assuming that the useful load is to be 450 lbs., which may be two people and luggage or perhaps one man and mails. The gross weight of the airplane will therefore be 3,000 lbs. and the h.p. of the motor 430. We will imagine that the airplane is of a type in which there is practically no resistance due to the slip stream of the airscrew; also that the motor requires no external cooling. In order to accommodate the engine and crew we will consider that the biggest cross section of the body is 12 square feet approximately round in section. The resistance of such a body will be about 2 lbs. to the square foot at 100 feet a second forward—*i.e.*, 24 lbs. in all.

The resistance of the rest of the airplane by careful design can be kept down to 16 lbs. at 100 ft. a second, consequently at that speed the total resistance other than the wings will be 40 lbs.

The area of the wings necessary will be goverened by the speed at which it is considered reasonable to land; taking 60 miles per hour as a possible speed and assuming that the planes can be converted into a deeply cambered section for landing, the permissible loading of the airplane will be 15 lbs. per square foot, making a total surface of 200 square feet.

We will now take a speed of 350 feet a second, or 240 miles per hour and find the horsepower required at a height of 10,000 feet—*i.e.*, where the density of the air is .74 of the normal. The wing drag may be taken as a fifteenth of the weight as with wings of varying camber we shall be able to get a high lift drag ratio even at a small lift coefficient. The resistance due to wing drag, therefore, will be 3000 ÷ 15, which is 200 lbs.

As the airplane is flying at 350 feet a second the body drag will be 3.52 times what it was at 100 feet a second, which will be 490 lbs. As, however, the air is 26 per cent less dense its resistance will be reduced to 364 lbs.

The total drag will be the sum of the body drag and the wing drag 564 lbs. in all. Taking an airscrew efficiency of 85 per cent on the power required for flying it will be very nearly 430, which is just the power available.

The example just taken may seem fantastic to many people here to-night; it must be remembered, however, that when the Wright Bros. were flying at 40 m.p.h., speeds of 150 may have seemed to them equally fantastic. On the assumptions we have made it is reasonably certain that a speed of four miles per minute can be obtained, and as motors of less weight per h.p. become available there is no reason why this speed should not be exceeded.

The rate of progress in increase in speed will depend upon the demand for speed. If war were to last it is almost certain that speeds of much more than 200 m.p.h. would be common in quite a few years from now.

Stability and Control

In the original Wright airplanes no attempt was made to obtain stability. The airplane was definitely unstable and required considerable care on the part of the pilot to keep it in equilibrium.

The early French airplanes were a little better in this respect, but the first airplane to prove that it really was stable —*i.e.*, it could fly without controls—was that designed by Lieut. Dunne. This was an airplane of somewhat curious construction and never became a success although it certainly was stable; on a windy day it was somewhat difficult to persuade it to fly on a straight course and its control when landing seems to have been insufficient. Lieut. Dunne, however, certainly showed that a completely stable airplane was a possibility.

About the time at which Dunne was making his experiments certain German designers claimed that they had produced a stable airplane. No record seems to exist of any test that proved their airplanes were stable, and in any case they certainly suffered from lack of control. The first airplane of normal type that was proved to be stable was produced as the result of experiments carried out by the late Edward Busk. An airplane known as the R. E. 1 was used for the first experiments and it was modified until it was made completely stable. Tests were carried out in order to prove that this airplane really was stable, and with Busk as pilot, carrying Colonel Sykes as observer, a flight was made from Farnborough to Salisbury Plain, in which the only control used was the rudder, and this, for part of the time at least, was worked by Colonel Sykes.

Since that day most English airplanes have been designed to be stable; it has been found that for purposes of fighting an airplane that is extremely controllable is necessary, and it has been also found that if an airplane is made too stable the controls are apt to become too heavy to make the airplane sufficiently sensitive. In modern day airplanes intended for war purposes the aim of most designers is to make the machine just comfortably stable over the range of speeds used in ordinary flight, but to provide sufficiently large controls that the inherent stability of the airplane can be entirely overcome.

It is often asked if we have stable airplanes why do we still have flying accidents? It would be quite possible to design an airplane in such a way that whatever the pilot did with the controls he would be unable to upset the equilibrium of the airplane. Such an airplane, however, would be valueless for fighting, and as practically all airplanes nowadays are made for war purposes there must continue to be an element of danger for the unskilled pilot.

Structural Strength and Size

Increase in speed and the increase in controllability both tend to increase the stress that will be put on the structure of an airplane in flight. Experiments have been carried out to determine the increased loads that are likely to occur when doing sharply banked turns and loops. It has been found that the load is frequently increased to three or four times the normal.

Present-day airplanes have to be very much stronger than before. Modern day machines that are expected to manœuvre rapidly are not considered tolerably safe unless the wings can support at least six times the weight of the airplane. Fortunately large airplanes for peaceful purposes will not be required to manœuvre very rapidly. This fact will have an important bearing on the possibilities of aeronautics.

In an earlier paragraph it was stated that the proportional weight of the airplane parts proper was more or less constant. This applied only to machines of the sizes that are used now —*i.e.*, up to about six tons loaded weight. As airplanes are made bigger, if they are designed on similar lines, the weight of the wing structure per square foot will increase, assuming they are to be designed for the same factor of safety. It is true that on the large airplanes now made this increase of weight is not very apparent because greater trouble is taken to economize in the design of the wings. This increase of weight, however, is likely to be important for machines of much larger size, but as we shall be able to use somewhat lower factors of safety the weight of the wing structure will not increase as rapidly as it would otherwise have done. There certainly is a limit of size to which it is possible to build an airplane; what this size will be the future will show. It is safe, however, to say there will be no serious difficulties in building airplanes two or three times as big as the largest we have considered.

Conclusion

The first few years in the history of flying have been years of remarkable progress and we are perhaps likely to be self-satisfied. We have no logical right to think that our flying machines of today are more than the crudest caricatures of the airplanes of the future. We engineers are a little apt to become so engrossed in our immediate difficulties of design that we do not see further ahead than is suggested by our own ideas, and make predictions for the future that only follow along the lines of progress that we can clearly see.

The writer has often been asked if he thinks that flying will ever become an ordinary means of travel. His answer is that he does not think, but that he knows it will become so. Ten years ago to attempt to fly from place to place was considered suicide; five years ago it was an adventure; today to many of us it is a very ordinary affair. When we get an opportunity to use the airplane in preference to the motor car, the train, and the ship, we travel at a miserable 100 miles per hour or so in a noisy, cold and drafty construction made mostly of canvas, wood and glue; yet we reach our journey's end far quicker and in a happier state of mind than by any other means. A few years more and we shall laugh to think of the airplanes of which we are now so proud, we shall shudder at the risks we ran, and we shall travel with comfort, speed and safety.

Seaplane Float Construction

Third Installment

By Charles G. MacGregor

Curtiss Aeroplane and Motor Corp.

Step Construction.—After the topside planking is complete the float is loosened from the mold, lifted off, turned completely over, and is set up on a padded mold for the completion of the step and bottom planking. The step floor is built very stout, and is rabbeted to take the stern bottom planking, and the inner skin of the bow bottom planking, the outer skin running to the after edge, or it may also be rabbeted in with the inner skin. A bulkhead is arranged, if possible, so that it will come at the step, in order to stiffen the float at this particular part. The keel, keelson, chine stringers and all longitudinal members are made strongest about the step. The lower edge of the keelson follows the line of the bottom planking to the face of the step floor, and then jogs up over the step to the line of the stern bottom planking. The keel ends are notched into the step floor (Fig. 22). The chine stringers are carried continuously past the step, and a wedge is riveted to the lower edge to make up the depth necessary for the step. This wedge is rabbeted so that the side planking carries down over the joint. The ends of the chine wedge and the step block are half-dovetailed and riveted. Fig. 21 shows the stern planking carried over the step block with the outer skin rabbeted. A cross member is screwed over the ends of the stern planking forming a clamp. The keelson is continuous with a wedge added ahead of step. The lower edge of the cross bulkhead is rabbeted into the floor or step block. Fig. 22 shows the method previously described. Fig. 23 shows the keel continuous where no keelson is used, it is passed through a hole cut in the step block and riveted when in place.

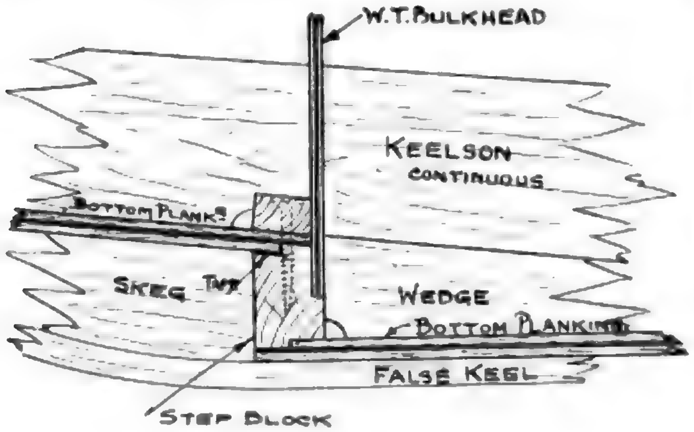

FIG. 21

False Keel.—To protect the bottom planking from wear and tear, a false keel is fastened on outside the planking, usually extending from about two feet from the stem to the after end of the skeg in the step float, and right back to the sternpost in the stepless float (Figs. 5-6). This is fastened on from the outside so as to be easily removable for replacement. Sometimes a brass strip is screwed to the underside of this for additional protection, as previously mentioned under "Keels."

The materials used in their construction are ash, oak, elm, mahogany and yellow pine.

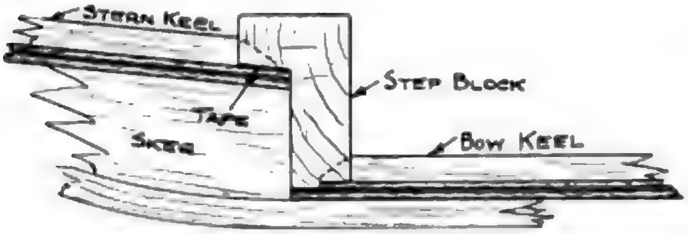

FIG. 22

Spray Strips.—These strips are fitted along the chines on the underside, so as to deflect downwards the sheet of water or spray that is thrown out from the bottom when the seaplane is taxi-ing, so that the spray will not catch on the propeller or propellers. They extend from two feet from the stem to the step.

The materials used for these are similar to those used for the false keels.

Skeg.—This is fitted at the back of the step in line with the keel. It is made of pine, ash, oak or mahogany. The lower edge is protected by the false keel. Sometimes a brass casting is attached at this point called a shoe, to protect and strengthen the skeg and step, at the same time providing a sturdy pivot for turning the machine on the slipway, etc., (Fig. 24). This figure also illustrates a metal skeg very often used in place of the wood one, and at the same time forming a shoe.

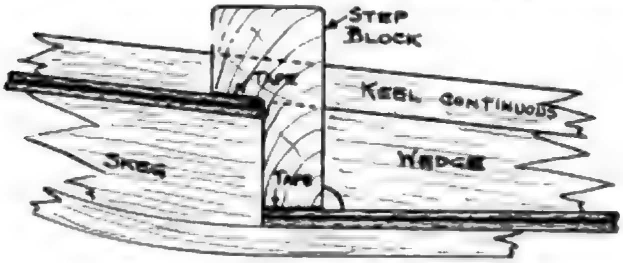

FIG. 23

Copper Edging.—Where the chines are not otherwise protected and are liable to be worn or chipped, a light copper strip is nailed over the exposed part. The nail heads are soldered to prevent them from becoming loose. The width of the copper is about ½ to ¾ in. on each side.

Air Tubes.—These are fitted usually behind the step, and extend from the deck down to the bottom planking. Their purpose is to admit air down to the back of the step to break the suction of the water on the bottom when the seaplane is running at planing speed, and so enable the machine to get off the water. They are built of sheet steel or copper. The ends are flanged over rings screwed to the deck and bottom planking, and soldered. The planking is reinforced with blocks around these holes. Packing is placed between the planking and the rings before they are fastened down to ensure watertightness. The Tee Tube is another type which is used where the separate tubes cannot conveniently fit in. (Fig. 25).

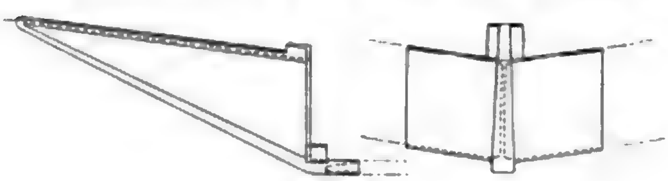

FIG. 24

Drain Plugs.—Each watertight compartment has a drainplug at it's lowest point, through which all the water can be drained. Two types are commonly used as shown in Fig. 26. One is unscrewed from the outside by means of a screwdriver. The plug is secured by a wire attached to it, projecting up through with a loop on the upper end inside, slightly larger than the drainhole to prevent it from dropping out. The other is somewhat similar with the exception that the plug is in the form of a thumbscrew, detachable from the inside and secured with a small keep chain. To permit the operation of these plugs the handholes must be removed.

Another method of extracting the water from the interior of the float is by means of copper piping, lead from the lowest point of each compartment to a deck-plate where the ends of all the pipes project through about 1½ in. The lower end of each pipe is covered with a brass wire gauze strainer. A small portable pump is used with a short length of rubber hose which is slipped over the pipe ends at the deck; or extensions of these pipes are carried up to a position convenient to the pilot's seat where each compartment can be pumped individually with the use of a multi-tube valve.

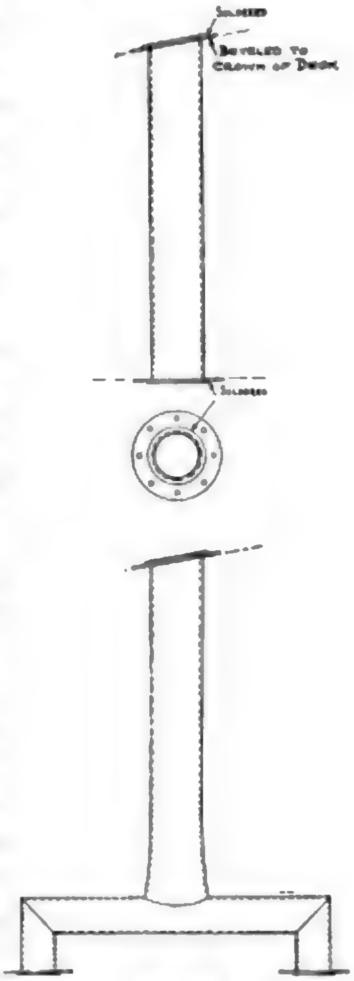

FIG. 25

Towing-Cleat.—There are several methods of towing a seaplane, such as from the bow towing ring (Fig. 27), from the deck cleat (Fig. 28) or from the struts. The towing hawser in the first method is belayed or tied to a U-bolt or ring bolted to the stem. (Fig. 29) The second method is that most commonly used as the fittings are particularly adaptable to towing and mooring. The towing hawser is rove through a closed chock bolted to the stem and is then belayed to the cleat on the bow deck, which is bolted through the deck to the interior bracing. The inside bracing is connected by metal straps or steel wires to the chine stringers or side keelsons so as to distribute the pull over the bottom. From the deck downward and forward, a strut is fixed to take the forward compression (Fig. 5). In the third case the towing hawser is shackled to an eyebolt through the strut at the deck connection, or to a special shackle on the pin joint of the strut. The machine is steadied by leading the hawser through the closed bow chock (Fig. 30). All these fittings are made specially strong and are securely braced to the interior of the float.

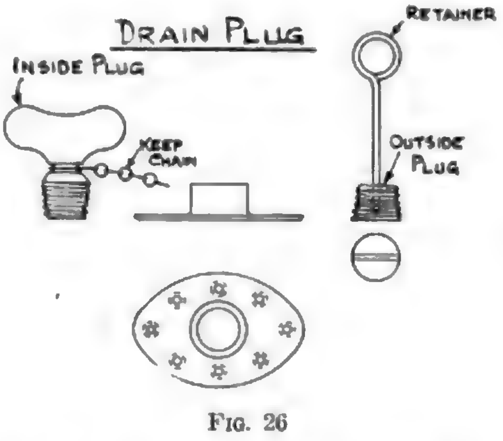

FIG. 26

Handholes.—Access to the interior of the float at each watertight compartment is obtained through handholes fitted to the deck. These are intended for access to the interior of the float, so that it may be ventilated, examined, have any interior fittings replaced or repaired, and so that the interior drainplugs can be operated. Several types of handholes used are illustrated in Fig 31. The first is the flat-rim screw-down flush handhole. The second is the curved-rim handhole of a similar type. The third is the dished-covered handhole. In the two former the cover screws down into the ring with a gasket between them for watertightness. A key is used to screw and unscrew the cover by inserting the stubs into the holes in the cover. In the third handhole the cover is in the form of a dished plate with a hole in the center through which a bolt projects, attached at its lower end to a tripod span with the ends inserted under the ring and made so as to be easily removable. A thumbnut jambs the cover over the grommet which is inserted between it and the ring. The ring is secured to the deck either by ordinary wood screws or by machine screws. The material of the covers is sheet brass for the dished plate and cast brass for the other rings and covers.

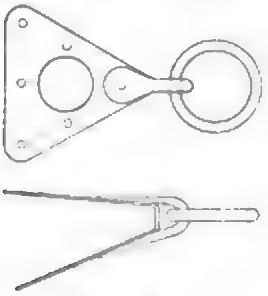

Fig. 27

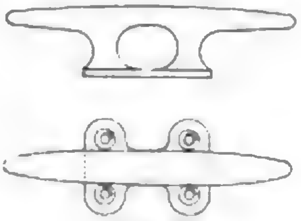

Fig. 28

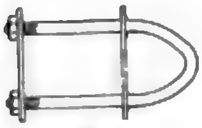

Fig. 29

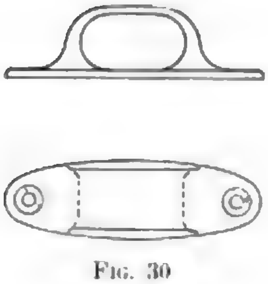

Fig. 30

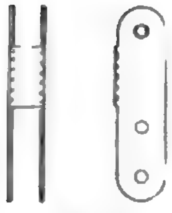

Fig. 33

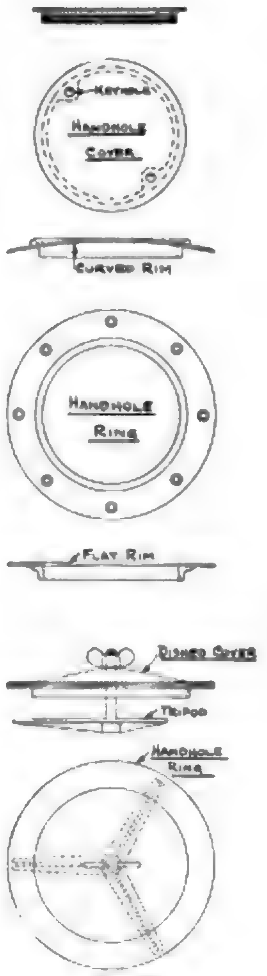

Fig. 31

Painting and Varnishing.—The use of white lead and red lead paints is eliminated as much as possible in float construction, on account of the weight added. Before the bottom planking is put on finally, the inside of the float and the inside of the planking are given three coats of varnish. The outside is given at least three coats of paint or colored varnish, each coat being well sanded before the next one is applied, so as to obtain a smooth surface, and thus cut down in the skin friction. The handholes are left open until the inside is thoroughly dry.

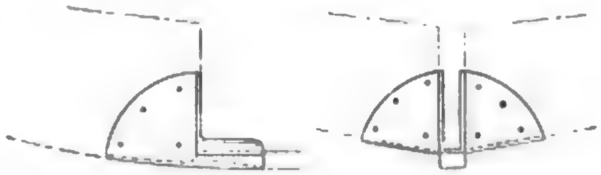

Fig. 32

These floats are very delicate and light in their construction; therefore, the greatest care is taken in moving them around. They are carefully padded if set on a cradle or on blocks, and if stored inside or left outside exposed to the rays of the sun, they are covered over with a damp sheet to prevent the wood from drying out too much and checking. Very often the fabric cover is torn or punctured accidentally, causing considerable delay in repairing the outside covering. They are and have got to be handled as carefully as wing panels.

A step shoe is shown in Fig. 32 and a heel clip frame in Fig. 33.

Book Review

Military and Naval Recognition Book, by Lieut. J. W. Bunkley, U. S. N. (D. Van Nostrand Co., 25 Park Place, New York, $1.00, 224 pp.).

This handbook contains official information on the organization, insignia of ranks and customs not only of the United States Army and Navy, but those of all the important nations of the world. It is attractively bound in olive-drab cloth, printed on heavy coated paper and profusely illustrated with fifty plates, both in colors and black-and-white.

The author first takes up the United States Army, and gives fully, but without unnecessary detail, its organization. All the departments of the Army are described, with their functions. The various ranks held in the Army are enumerated so concisely as to be easily understood. Etiquette and customs, both official and social, are treated in two chapters. The United States Navy is covered in the same comprehensive manner, and the Marine Corps, the Coast Guard, Lighthouse Service and Coast and Geodetic Survey are touched upon in separate chapters.

The author gives ample space to the organization of the army and navy services of the more important foreign countries, and the army and navy uniforms of the United States, Great Britain, France, Germany, Italy, Austria-Hungary, Japan, Russia, Belgium, Turkey and the Balkan States are fully described, with many illustrations.

The various war medals of the United States are described, as are the ribbons used for the medals and badges. The last of the twenty-four chapters defines guns of different classes and their parts.

The illustrations in Lieut. Bunkley's volume deserve special mention. They are grouped in a logical manner, and by the large number of color plates identification of insignia is made a simple matter.

This handbook was prepared not only for men in the services but for everyone interested in the uniforms, insignia and customs of our fighting forces, and as such should prove an exceedingly useful and popular reference book.

Aeronautical Patents

ISSUED NOVEMBER 27, 1917

1,247,685—To Joshua Gaskill Jackson, Buffalo, N. Y. Flying machine.

1,247,727—To George C. Schule, Herisau, Switzerland, assignor to Otto Schule, Neu St. Johann, Switzerland. Flying machine.

1,247,802—To Frithiof Gustaf Ericson, Toronto, Ontario, Canada, assignor to Canadian Aeroplanes, Ltd., Toronto, Ontario, Canada, a corporation of Canada. Airplane construction.

1,247,960—To Martin Jelalian, Cranston, R. I. Hand-power propelled hydroaero sporting dirigible balloon.

Aerial Transport and Travel[*]

By Lieut.-Col. Mervyn O'Gorman, C.B., D.Sc.

There is talk today of aircraft for transport and travel. The carriage of goods, mails, and people, the exploration of remote districts, the conduct of photographic surveys, the searching out of valuable trees in pathless forests, the speedy conveyance of officials to their administrations in distant climes—these things and others are everywhere hopefully dwelt on by the imaginative among those engaged in air work. It would be grossly unjust to say that such hopes and fancies detract from the energies which these persons expend on their war duties; they rather indicate the intention of winning and of carrying on thereafter the life of a virile community.

In a paper before the Aeronautical Society, in June this year, (see Nov. 1, 1917 issue of AVIATION AND AERONAUTICAL ENGINEERING) I gave reasons to show that in the interest of the war we must care about the future of transport by aircraft. I will recapitulate the position under *A*, *B*, and *C*, for there are three stages in the logic of the matter:—

The Three Stages

A. We are to have an Air Ministry and an Air Force: the Act shows that they are not temporary—a token from which alone we may say that we intend to have a fighting Air Fleet.

B. An air fleet differs from a sea fleet in being much more easily expendible. No one would dream of rebuilding the British High Seas Fleet six or eight times per year of war, but an air fleet in action requires, and will continue to require, at least this. Thus the airplane has in this context the interesting singularity of being intermediate between a cartridge and a battleship. It is not quite so rapidly expendible as the former, but it is an expendible munition, and when we decide to have an air fleet we also decide, in logic, on the third conclusion, *C*.

C. This corollary is that we will maintain an aircraft construction organization in peace that shall be competent to produce some six or eight air fleets per annum in war.

At present we have such an industry—not large enough, perhaps, but we have at least a live and flourishing plant which is bearing fruit, which can grow, and which, be it noted, can also expire. A living organism can be killed by deprival of oxygen. In three minutes a man is drowned, and 40 years' training of brain and hand can be thus quickly reduced to an inert mass. Similarly rapid is the rate of disintegration of a highly organized technical production department like the Aircraft Industry if it be starved. Today war orders continue at full flood to fill up the wastage. If they stop suddenly we shall find within three months that the shop organizations are broken up, that all that remains to us is the husk; we shall realize that we could, by timely measures, have saved much of our expensively purchased experience and organization, and have retained a value far greater than the mere buildings and plant. Once the designers and workmen are scattered, that which is so difficult and expensive to build up will be gone. Our capacity for the production of aircraft will be an object of derision like a bouquet of hairs in an old broom.

This simile will have succeeded if it has led a few score of persons to inquire, "What on earth are we to do to keep this mechanism of production in being without keeping up in peace the war rate of expenditure?" A part of the answer was outlined in my first sentence; we must so utilize aircraft on commercial duty, and so nurse it in its days of trouble, that it shall itself earn the best part of its keep.

If aircraft using can be induced to pay, aircraft making will of itself continue. But, in spite of the firmest belief in the value of aerial travel, the mere institution of services takes time. Neither three months, nor six months, nor a year, will see a thriving mercantile air fleet engaged on its routine duties and issuing its routine orders on which the construction business depends. Yet a less period of inaction than this will extinguish the industry. This is the period I ventured to call the "hiatus" in the discussion on Mr. Holt Thomas's historic lecture last May. To bridge the hiatus we must do something *now*. There is no other alternative. No one expects a continued unrequited expenditure of from 25 to 50 million pounds per annum on aerial war material in peace time. On the other hand, no one would object to our making even this large amount of aircraft if it nearly earned its keep by remunerative services in any of the travel and transport businesses, or even if we could be assured that, after a period of Government support, it would eventually draw near to the standing of a self-supporting industry.

Historic Precedents

If we look back to the birth of the railway and the steamboat we see that for some years they struggled against public apathy—though their potentiality for good and for the creation of wealth and trade was almost as great in Watt's time as now. This apathy, amounting to boycott, rendered them unremunerative for a long period, and deprived the world of travel, and joy and change, and fresh air, and trade progress for well nigh a generation. In the case of the road vehicle, which we now call a motor-car, we had something worse than apathy—we had legislation for the alleged protection of the public, all meant in kindness—which killed the motor-car of 1837 and retarded the car of 1892, till France was well ahead of us. In the case of dynamo electricity we underwent a process of protective legislation against shock and fire possibilities, which threw us well behind Germany and the United States. The story of legal impediments to scientific advance makes one wonder whether we are a free people—that is, with freedom to advance, or are we only set on freedom to stagnate?

The greatest danger that aircraft has to fear, after public apathy, is legislative interference. It is not that the British law, excepting only when it is panicky, is worse made or more malignantly administered than another. The kindly intentions of legislation towards the public are generally as laudable as our laws in technical matters are detrimental. Yet such a community as ours can only live and thrive on its technicians. We are prone to drown the puppy lest he should bite, instead of adopting our own unique maxim of allowing the law to lag, so that the puppy shall have one fair bite before he is muzzled.

Anti-Progressive Legislation

We now know that it was shameful to have waited for the war before building up our Department of Scientific and Industrial Research. No branch of administrative expenditure was known to pre-war politics whose function was to venture forth, or to encourage us by Press publicity, or otherwise to advise the public to risk a little inconvenience during the period of evolution of a difficult art or science. The four-mile, the twelve-mile, and even the twenty-mile per hour motor-car speed limit prove that technical legislation has hampered and did not encourage. Of legislation relating to aerial transport it may safely be said that it is a case requiring the greatest delicacy of handling. It must be taken as certain that Government assistance, I do *not* say subsidies, for the industry must be forthcoming unless it is doomed, but even if this assistance were certain there remains cause for anxious thought today.

The danger of Government support lies in the conditions which a self-protective public is liable to impose before the technical possibilities are sufficiently known to form the basis for any sort of legislative interference. These conditions are liable to be all the more onerous since they could be imposed as of right, and regarded as a *quid pro quo* for the "*assistance.*" The fearful might say that great unknown risk to those on the ground (*omne ignotum pro magnifico*) is involved in any program of commercial aeronautics. The braggart has already talked of a sky darkened by airplanes, of the cerulean clotted with colliding aircraft, and the timid voter silently wonders how *he* is to be protected from the debris. Luckily we have the facts with which to dispel this apprehension. Today we may safely say that £50,000,000 worth of aircraft is yearly poured out from this country's factories. The large majority of this is flown to its destination, or used for tuition and defense at home, yet we still see the sun.

We have a full measure of the nuisance exaggerated by the more hurried training of fliers, and the extreme lightening of structure imposed by war conditions. Such nuisance as there is is purely local, and is really negligible. Now there is no prospect for many a long day of any such £50,000,000 output on commercial aerial transport. It is merely necessary to recall that our total expenditure on merchant shipping is a mere fraction of this to see the absurdity of apprehending and legislating as if we were to have this immense user of aircraft.

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[*] A lecture delivered before the Royal Society of Arts.

There is no slightest probability of any nuisance in excess of what little we suffer today, even if we had, which I see we shall not have, an aerial fleet of this magnitude.

I have indicated the need for restraint in law-making, but there is also need for positive official action, if the bells that ring in peace are not to sound the knell of aerial activity. The Allies must, during the war, frame a joint policy as to the tolerance of each other's trade and postal aircraft, and agree to air routes throughout the parts of the world which they control. With the large expanse of our colonies and our own industrial and postal importance, we have much to offer to the Allies which will be a valued equivalent for that which we shall obtain from them in the way of alighting rights. Being an island, and accepting, as we must accept, the proposition that the most significant section of aerial transport will be outside the confines of Britain, we need that our Allied neighbors shall extend, not only tolerance, but welcome to our machines when engaged on their transport work. We and our colonies should have to be prepared, and, I believe, are prepared, to extend a corresponding welcome to their airmen at home.

Preparing for Peace

International agreements, even though simple in subject-matter and non-controversial, are always long drawn out. Everyone who understands factory organization will agree that we cannot afford to wait until after the war for these parleyings to begin. Our aeronautical organism will assuredly become disintegrated too quickly. If we can get four or five willing men round a table to agree to admit aircraft mutually, to register them, to agree to simple preliminary rules of the road, and to agree that their respective countries should initiate a few lines of landing-grounds so as to constitute safe routes, the early days of trade flying have little more to ask for from the foreign offices of the world.

No doubt in some four or five years of active aerial transport organization work the paltry fifty or hundred airplanes of our early post-war efforts at transport and travel will have grown up into a significant carrying trade for high-speed work, large quantities of aircraft will have been used for commercial purposes, and it will be found useful to introduce, and there will be experience enabling us effectively to introduce valuable regulations for the protection of passengers in aircraft, and the public on the ground beneath. At the present day it is clear to all who have eyes to see that no adequate knowledge exists on which to frame rules with discrimination and without grievously hampering technical development.

The Danger of Safety

I can imagine a legislature winning a round of applause from the *inane vulgus* by driving a hard bargain with the wretched trader, who, in the face of starvation, might accept any regulations, however hampering, in exchange for the means to live. I can imagine the imposition of tests of airworthiness, strength tests, the enforcement of hobbies such as multiple engines, silencers, special alighting gears, the carrying of parachutes, fire extinguishers, wireless equipment for calling for aid, and countless other things, which may, no doubt, come in their own time, but which would clog the versatility of the engineer, and for years condemn to unproductiveness the nascent industry of air travel. The payment of an army of inspectors would be put down as encouragement money, and would be a charge against the aeronautical vote. A landowner would ask for the power to capture the flier who has most reluctantly alighted on his ground. He might ask for a law allowing him to impound the airplane, on the chance of his registered number being inauthentic, and so secure payment of the damages which he wishes to claim.

It is just possible that regulations of this sort might meet with support, as much as support is at present accorded to the 20-mile speed limit of the motor-car. They would be next to impossible to remove, though they might be demonstrably hampering the aircraft development of the country to an enormous extent. The intentions would be good, the desire would be to secure that only the best aircraft were used, and that the public suffered no injury by its use. It was for half a century thought that the public could suffer no injury by the four-mile speed limit being imposed on mechanical traction! Later it was thought that as a 12-mile an hour speed limit was ample for a coach-and-four, it must be an ample speed for a car, and so the automobile industry passed to France and Germany, in spite of the fact that the first car plied for hire in England early in the reign of Queen Victoria, when there was no speed limit.

A Safe Prophecy

Let us rest assured that the amount of civil aircraft will for some years be so much less than the amount of military aircraft now existing, that the total of damage to property and inconvenience to the public, which we at present know to be small, will be much further reduced in proportion to the lesser numbers, the future technical advances, and the less strenuous conditions of manœuvering imposed on peace airplanes.

Labor

Labor.—Among the expectations based on aerial transport and travel are those of employment for individuals throughout the whole social scale as well as officers and men from the Army and Navy. Our producers, and therefore their employment of labor, depend on the bodies which employ aircraft—viz.: (a) Primarily the Air Force; (b) foreign buyers, nations and colonies; and (c) companies instituted for transport and travel, including postal duties. All these bodies need labor, and all are interested in continuing harmonious relations between those who direct the work and those who manually carry it out.

It has been suggested that since the aircraft industry is a new industry, an exceptional opportunity exists of introducing a totally new atmosphere of harmony unembittered by the old trade quarrels. This is most desirable, but the novelty of the technics of aircraft has not *in fact* eliminated the old trades at all; on the contrary, it has developed the demand for these "tradesmen." The Aircraft Industry is not a new trade in the sense in which that word is used by the world of labor in the phrase "Trades Union." The Aircraft Industry includes members of almost all the engineering trades, as well as important additional trades, such as woodworkers, carpenters, organ builders, cabinet makers, fabric workers, etc., and it is necessary for that harmonious relationship to be established between employer and employe, in spite of the fact that the history of all the old trade differences will unavoidably be also the history of the persons and corporate bodies imported into the new industry, with this addition, that a trade quarrel on the subject of organ pipes or on the piece-work price of chairs, may mean a stoppage of airplane work, owing to the newly imported craftsmen holding on to the old unions.

Again, it would be unintelligent to pretend that aircraft making can be developed under a compact between employes and managers which shall guarantee continuity of employment for all the manual workers in exchange for a continuity of labor supply to the other. The difficulty is a fundamental one, and perhaps is a worse difficulty in the Aircraft Industry than in most others. It is this. The technical developments of the art, the unforeseeable shortage of material, and the unavoidable changes of method and of materials, tend, let us say, at one time to the employment in an aircraft factory of 50 per cent of wood workers and 30 per cent of steel workers, and there is no human authority who can with sanity pretend to say that in some brief time these proportions will, or will not, be widely changed. If steel or aluminum were to form a greater part of the structure than they do now, because of safety, or diminished fire risk, or what not, any agreement with the wood workers' union for continuity of their employment would install them as a paid but non-working body of pensioners on the industry. Alternatively, British aircraft, hampered by such an agreement, would remain locked in its old technical groove and be debarred from adopting the devices and inventions which throughout the rest of the world would be improving the machine. Surely a hopeless prospect for a technical service required for war!

It is clear, then, that the agreements between manual and brain workers on aircraft must be part of the general agreement on which our new millennium is to be based.

To Save Disappointment

Employment of Soldiers and Sailors.—The industry will, even when the most strenuous efforts have been made to save it by such continuance of air service orders as are at all possible, and when such aerial transport work is started as may be decided on, still be cut down drastically. Hence very great disappointment will be spared to many a good man by realizing thus early that there will be no expansion of employment on aircraft which will absorb them wholesale, but rather a manifold shrinkage.

Public Contact

Accidents.—It is unfortunate that the chief contact which the public of England makes with aeronautics is in relation to accidents and casualties. The achievements appear, it is true, but it is almost impossible to visualize them save perhaps in the case of an occasional flight of unusual distance, such as the recent 3,000-mile flight from London to Constantinople, or between London and Turin, and these things appear to be disconnected items giving no impression of the hundreds and thousands of miles of continual flying which is taking place. These show flights are few, not because they cannot be frequently achieved, but because war does not provide for show and *réclame*. The public cannot by mere lecture be brought to the point of view which is standing with those who have been fully familiar with aircraft; we are so imbued with its utiliy and versatility, that we are no more discountenanced by occasional breakages than we are deflected from hiring a taxi by seeing a sideslip against the curb. Those actually engaged in design, who naturally need to use every element of experience which accidents may bring to enable them to perfect their work, are anxious to study and analyze these occurrences.

Reasons for Accidents

Air accidents can be divided into groups for the purpose of their study, and when we proceed so to divide them we find that by far the largest category includes those which are due to the two following circumstances: (1) The absence of landing-grounds distributed in easy stages to which a flier can turn for refuge if his engine should stop; (2) the inexperience of fliers themselves, since the majority of the experienced have been drawn off to the war. If we remove from the records of accidents, other than tuitional, all those which could have been avoided were these causes non-existent, the residue would be less significant in *fact*, and vastly less significant than is the *impression* abroad. Beyond this it is still reasonable and advantageous to sub-divide the causes of this residue of accidents into classes, so that attention should be drawn to that which may be eliminated, be it in design or in handling.

Of the remainder, the most important is what is commonly called "Pilot's error." This does not imply that he is blameworthy. In war, manoeuvres which are definitely hazardous are necessary; people may be surprised to hear that to loop the loop is a useful war manoeuvre which may greatly puzzle an antagonist in the air, since the looped path takes the place of the expected forward movement, and therefore falsifies the aim of the adversary, or throws out all his estimate of the direction in which to fly for purpose of intercepting him. Another manœuver, known as "spiralling," or "spinning," if contrived to give the impression that the airplane has in fact been thrown out of control, is one of many ruses for breaking off a fight. The learning of these manoeuvres must be achieved before they can be used in war, and tends to swell the number of broken machines. Rapid diving, such as might be made in an attack on observation balloons, may similarly be a cause of accident until judgment is acquired in the method of "flattening" out the dive. Even to describe a *very* small circle in a horizontal plane implies unusual stress on an airplane, if accomplished at high speed. None of these manoeuvers are called for in trader work, while, to add to the comparative safety of the peace aircraft, we can appreciate the effect of removing the war demand for high performance and speed. Under fire and pursuit safety comes from lightness and manoeuvrability, as much as, or more than, it does from strength and solidity; in trader work the conditions are largely changed if not reversed.

Reduced Risks

Aircraft travel and transport therefore will, if landing-grounds are provided, not be exposed to any of the risks above named, and accordingly from the list of accidents which occur today we must eliminate almost all these in any prognostication as to the future safety of flying. Before such an audience I need not belabor the so-called *air pocket*. It never did exist, and generally there seems to be little probability of any airplane, even when designed on the factor of strength used today, with the limited science of today, being broken in the air under the conditions of aerial travel.

Much need not be made of the fire dangers on aircraft, for when the matter is regarded dispassionately, the fire risk by actual experience is small. Of the fires which have occurred since thousands of airplanes have been turned out per month, the large majority have arisen when the airplane has struck the ground and the petrol vapor from the broken up tanks has come into contact with a spark. Now this breaking-up of a machine on the occasion of a forced landing again becomes a rare occurrence if the line of landing-grounds suggested for aerial routes is provided. Most of these smashes, some fraction of which have resulted in fires, have occurred by reason of the flier holding up his machine unduly long in his search for a suitable place to alight in a country where no provision for alighting exists.

Increasing Safety

Of the mechanical precautions taken to avoid fire, we know that already it has been possible to make a magneto which, when filled with explosive vapor and surrounded by it, gives rise to no ignition of the mixture. We have also learnt that the back-firing or "popping" of an engine into the induction pipe, which throws a flame back, can be made innocuous by drawing the air supply of the engine from outside the body work. This, indeed, is standard practice today. The use of electrically heated clothes, called for by fighting at heights such as 20,000 ft., will not be nominally desirable, and as for appliances for wireless telegraphy, which will have their place for giving trader craft their direction and for calling to the ground, they will not under peace conditions impose any risk of fire which cannot be circumvented. In general, the standard of safety from this point of view will be automatically enhanced in all transport work. Carelessness, such as makes people bring matches into a T.N.T. factory, cannot be expunged from the human race, but this class of occurrences need not disconcert us at all. In filling up with petrol there is the chance of spillages, and no doubt but that every aerodrome should be equipped with portable fire-extinguishers of light weight made available at filling points, and no doubt also but that all large airplanes will carry one in an accessible position, until the proved absence of utility causes them to be relinquished.

Fog Dangers

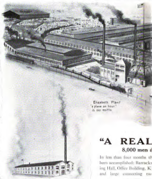
The accident, if it can be so called, of losing one's way in a fog will be far less likely to result in disaster, when, to quote it once more, there exists a multiplicity of landing-grounds, because, on the one hand, no fog has been found to extend more than a very limited height, say, 700 yards maximum, and, on the other hand, because we now know that fogs are quite local in their occurrence at any one moment. A befogged flier, instead of alighting through a foggy patch, merely moves a little farther on before landing. This does not imply that projects for signifying to a flier who is above the fog the correct position of his aerodrome by pilot balloon or raised lights are to be discarded, but this is not the place to deal with that point.

Parachutes

Parachutes are spoken of, but by many fliers are not thought particularly desirable. We know that at present they require a height of some 500 feet to open out and afford the safety which they appear to offer, and it is usually below these levels that the flier becomes convinced he is to be exposed to some risks, say, by the conditions of the ground together with the stopping of his engine which causes him to alight. One would have to be very seriously out of touch with those who fly daily and really know their job, if one continued in the impression that numbers of accidents are the inevitable concomitant of aerial travel, and it is sufficient to say that any such opinion may be dismissed as one which has arisen from the peculiar conditions of Press publicity in war and the exclusively high pressure and high performance conditions of the development of aeronautics up to today. The lack of contact of the public with the serious and successful work which has been achieved has already been mentioned.

Wind Tunnels

Research.—It is possible that someone will question the need for research and for State endowment thereof; it may be said that we are well on and can now trust to practical developments, since root and branch retrenchment of expense is called for. This is a complete *non sequitur*. If cheap progress is wanted, the cost of progress is enormously reduced by making and testing models two feet wide instead of making structures of a 100-foot span. The ratio of cost is as £10,000 to £50, and it is the £50 scheme which I am advocating. I cannot


Elizabeth Plant
"a plane an hour"
is our motto

Plainfield Plant
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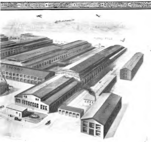

. FIGHTING INDUSTRY"

ind women in this army taking trenches by production

is has
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building being built and put into service.

Ten Plants within a radius of one hundred miles are devoting their entire capacity to Standard production efforts.

AIRCRAFT STANDARD CORPORATION

AN HOUR" our motto ELIZABETH NEW JERSEY

give a list of researches, but ask you to consider the following examples. We need the scale corrections from model parts to full size; we need to test propulsive mechanisms, without building them; we must know the value of new wing sections; of reflexed wings; of hinging the flaps for controls; we must, in order to get any airplane stable, know the movement of the center of pressure on the wings when the attitude of flight is varied; we must study the effect of vibration on structural parts, etc.

We are aware that the great utility of aerial travel is speed, that the great enemy of speed is head resistance, and we must be able by simple model tests to forecast the speed which will be attained by a given design. We must be able to know, before we introduce a variation in design, the amount of economy of resistance which can be made by altering structural parts. All this class of work can be effected in the wind tunnel, and already most serious aeronautical construction firms are equipping themselves with a wind tunnel. Probably the greatest value of such equipment is its educational effect. The wind tunnel has fought its way to the front, in spite of much opposition, and it is still to be recognized that unless its indications are interpreted by skilled persons grave blunders will be made, but this in no wise detracts from its utility when properly employed.

Engines, Air Screens and Other Things

We are aware that the thermal efficiency of engines employed on aircraft is as high, in spite of their small size and weight, as the efficiency of Diesel engines giving thousands of horse-power. Yet this figure is only 30 per cent, and by research alone can we hope to obtain an extension of this percentage. The study of airscrew efficiency, the effect upon it of the body, the means for making airscrews smaller than they are at present, and thereby simplifying the whole outline of an airplane, is a matter which research must tackle. The use of new alloys, of new methods of totally enclosing the flier in an airplane, new methods of housing the landing gear, so as to get rid of its head resistance, the protection of the fabric of the wings from disintegration by ozonization due to actinic light, all these and countless more matters can only be economically and expeditiously studied in laboratories equipped for the purpose, they will effect enormous economies in aeronautical upkeep, and aero research must be pressed on and financed after the war.

Broadly, it may be said that air transport will not develop save by taking a line of footprints given by research. To say that we want it, does not by any means ensure that it will proceed apace as it should. Research of various kinds is remunerative in two different ways: (a) quickly; and (b) eventually. Those studies which conduce to (b) rarely produce (a) a quick return. On the other hand, researches which afford us (a) are very likely indeed to be remunerative both quickly and eventually.

If we now subdivide the various researches which might forward aeronautics into two other classes—those (a) which result in some proprietary advantage to the inventor, and those (b) which have a general effect on progress, and which are not susceptible of being privately protected—we find that there is every inducement to the research worker to concentrate upon the class of improvement which I have called (a) in each of the above pairs of groups, that is to say, the device which can both be made proprietary, and which is remunerative quickly.

This must, unless we are very foreseeing and courageous, operate to deflect research workers from the other and frequently much more important class of study, viz., those which are of *general* application, and those which are eventually of great money value to the whole of the industry, whether of construction or of transport.

Patent laws stimulate advancement by providing that there shall be a reward, and that all and sundry shall not be able to possess themselves of the fruits of one man's labor, and thereby dispossess him. Means must be devised for securing that the British industry, as a whole, shall not be tempted to exclude from its study the great groups which I have classed as (b), which are so frequently not protectible by patents; and this business falls naturally to the new Department of Scientific and Industrial Research, who will, no doubt, find the hearty cooperation of the Society of British Aircraft Constructors and the Aeronautical Society. It is for the public to see that the determination toward progress exists, and then the outcome will first of all be the necessary funds, and thereafter the harvest of results and economies.

The Air Board has formed a Civil Aerial Transport Committee, which is engaged in considering these and most of the other matters dealt with in any such discussion as this, and if they recommend active steps to be taken, let us hope that there will be firm public support for any expenditure and assistance which shows proper foresight, always with the considered approval of the new Air Minister.

Air Roads

Routes.—One of the things wanted now is some inquiry made experimentally by actual flight for the purpose of determining the best aircraft trader and postal routes which may be useful and eventually payable. London-Paris has been suggested, with extension to Marseilles, Turin, and Egypt. Links between capitals have also been spoken of, and links with India and South Africa, etc. Short runs will probably come first. In all short distance runs the problem is complicated when the existing rail and steam facilities compete. There is a marked advantage for aircraft every time that transhipment of any kind occurs on the ordinary means of transit. This favors London-Paris and London-Dublin, for example. Similarly, and for similar reasons, whereas no great advantage might be gained by a London-Glasgow route, where the train travels at fifty miles per hour, and the journey can easily be done during the lost hours of the night without the traveller being roused from his sleeping berth, we shall find that cross-country journeys, those involving changes of train, waiting at stations for connections, will be instantly eclipsed in comfort and speed by aerial travel and aerial mail deliveries. One could suggest Cardiff and Newcastle, or the like.

I do not think that much is to be gained by suggesting routes at the present moment, unless we propose to permit a few machines to be withdrawn from war service, and then, by using a few pilots who are for one reason or another not fit for war service, explore the practical possibilities of such transport. I think it far better to start by carrying newspapers and letters, and packets, rather than passengers at first, for every reason. The routes will be unknown to the pilots, their experience may perhaps not be great—the advertisement cannot usefully be made in war time, and, generally, it is not desirable, save in exceptional cases, to expend petrol for personal travel, or to expend money in adapting designs to passengers' comfort. Yet if this comfort were omitted, a false impression of the facilities to be afforded would easily get spread abroad.

I do not know whether certain types, whose performance is below the ever-rising requisites for war, could be made available, but I should have thought that with good will they could be managed, and if so, the experiments made in war-time would help us to start *quickly*, on declaration of peace, that which might eventually help to create orders—only a few it is true, but still a small fraction of what is wanted for the maintenance of the production factories.

Future Speeds

Speed.—I am inclined to endorse Mr. Holt Thomas's view that, if we consider the average wind speed as 30 miles per hour, sometimes with us and sometimes against, we shall need machines whose own air speed is 120 miles per hour, in the case when there is any competition with other means of transport.

On cross-country journeys far lower speeds will be vastly faster than the existing systems, and will at once command attention.

As we know, 120 miles per hour is a very ordinary speed today for aircraft, and offers no technical difficulties in alighting—indeed, Captain Green's interesting forecast, under certain conditions which he laid down, of an airplane to travel at 240 miles per hour, did not appear to raise any feeling of doubt or hesitancy at the Aeronautical Society about three weeks ago—though a similar audience in 1911 was very skeptical about the advisability of introducing, even for military purposes, my proposed speed of 72 miles per hour. This gives us an idea of the changes which have gone on in men's minds by legitimate extrapolations from the actual achievements with which they are familiar.

I have nearly finished, but before doing so I must once more reiterate that the most hopeful estimate for immediate aircraft transport and travel does not save the situation. There must be Governmental action to maintain the country's productivity and designing capacity for military and naval aircraft in the first place, and as the mainstay of the country's factory organization.

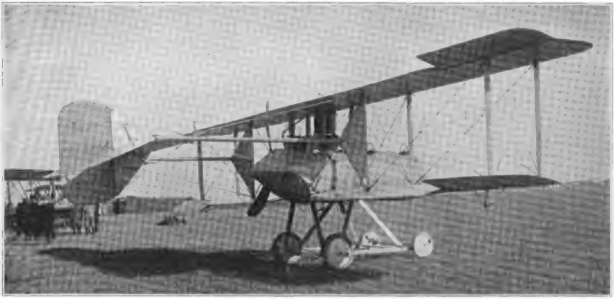
A New Arena

In conclusion, it is only half a truth to say, with Frederick List, " The sea is the high street of the earth. The sea is the parade ground of the nations. The sea is the arena for the display of strength and enterprise of all nations." There is now the air. A great instrument of power tending to peace and usefulness and good will can be designed in a week, if only a British, a French, an American, an Italian plenipotentiary could be empowered to sit around a table. That instrument is the aerial way. Its regulations must not be founded now upon speculations, they must be evolved later upon experience.

All the Allied nations desire the same thing, all are agreed that just as in time of peace we must prepare for the catastrophe of war—so in war we must prepare our thoughts and plans for the cataclysm of peace. The word is used advisedly, for a very sinister situation will develop in the world of aircraft during the hiatus which first was publicly indicated, I think, by myself, in the discussion on Mr. Holt Thomas's paper before the Aeronautical Society, and which Lord Cowdray himself promised to make every effort to bridge.

The Continental Pusher Biplane

An interesting type of pusher biplane has recently been produced by the Continental Aircraft Corp., of New York City, to the designs of Louis L. Kaess and Vincent Buranelli. To date, the machine has been in the air for over forty hours and has furnished an all-round satisfactory performance. During the severe cold spell, in the latter part of December, the machine was flown by Bert Acosta from Central Park, L. I., to Amityville, N. Y., over a triangular course of 60 miles, which was covered in 45 minutes at an average altitude of 5000 ft. The thermometer on the dashboard indicated eleven degrees below zero.



THE 110 HP. TWO-SEATER CONTINENTAL BIPLANE

The Continental pusher biplane has a span of 36 ft., with no overhang, sweepback or transverse dihedral. The overall length is 22 ft. The power is furnished by a 110 hp. Hall-Scott engine, model A-5, driving a three-bladed airscrew.

The wing curve is a U. S. A.-5, and the wings have a safety factor of 8, the lift loading being about 7 lb. per sq. ft. The gliding angle of the machine is about 1 in 9.

Among the notable features of the machine is the connection of the tail planes with the wings, which is secured by means of two steel booms. These are inserted in triangular steel frames, covered with cloth to reduce head resistance, which take the place of the inner rear interplane struts. The booms are suitably trussed to the upper and lower wings. The tail planes are of the usual fin-and-flap type, the empennage being non-lifting.

The body is a well stream-lined monocoque construction, which embodies some interesting details, such as the mounting of the engine on heavy veneer panels, which are slotted around the crankcase, and act as engine bearers. A suitable trap-door permits the removal of the engine by lowering it to the ground, which dispenses with the necessity of taking down the wings. To complete the stream-line shape of the body, the airscrew is encased into a conical cowl. A starting crank is provided for the convenience of the pilot, who occupies the rear seat; the latter is hinged so that it can be raised when the pilot wants to start the engine.

The control is of the Dep type, with a post taking the place of the yoke. The mountings of the control post and the rudder bar form a unit, with the return pulleys of the elevator wires being mounted on the pedestal of the rudder bar.

The undercarriage is of the two-skid, four-wheel type, and is connected to the body by means of six stream-lined struts. Ackerman wheels, 26 by 4 in. at the rear and 20 by 2½ in. at the front, are mounted on rubber-sprung axles. To slow down the speed of the machine after landing, tusks are provided on the rear end of the skids; these tusks dig up the ground upon negative incidence being given to the elevator flaps, exerting thus an effectual brake force.

The accompanying illustration shows that a great amount of ingeniousness, if not ingenuity, has been expended on this machine with a view of reducing head resistance to a minimum. This object is particularly difficult to achieve on pushers on account of the material parasite resistance offered by the tail outriggers. The designers of the Continental pusher claim that their tail boom construction eliminates about 80 per cent of the resistance generated by the old Curtiss or the Farman type of outriggers, a claim which looks well acceptable in view of the great amount of cross bracing and trussing the said outriggers require. Altogether, the Continental pusher strikes one as a distinctly original design, and one having, on this account, substantial merit.

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consumption would be about 600 lb. per hour. If it were employed upon an aerial route 1,000 miles in length at a speed of 50 miles per hour the total weight of petrol to be carried would be 12,000 lb. or let us say 6 tons to allow a margin for safety. On a journey of this length, then, the airship could carry over 17 tons of goods, or 146 passengers with 100 lb. of luggage each.

This gives some idea of the capacities of these craft from the purely utilitarian point of view of the amount of weight that can be carried, but there are many other reasons for claiming that airships cannot be summarily dismissed from consideration as commercial vehicles.

Another great argument in favor of the airship as a passenger-carrying vehicle rests upon its ability to remain in the air even in the event of complete failure of the power plant. It is true, of course that in such circumstances it will be at the mercy of the wind and drift out of its course, but at the same time there will be no necessity to jeopardize the lives of the passengers and the safety of a valuable cargo by making an immediate descent whatever way be the nature of the ground or sea beneath. This applies particularly to journeys at night or in fog, when the risks of engine failure in airplane are almost a nightmare.

To avoid the perils consequent upon engine breakdowns, heavier-than-air craft will be compelled to fly at a height of at least 4,000 or 5,000 ft., whereas the airship pilot can cruise, and in fact prefers to do so, at any height from 1,000 ft. downwards. This adds enormously to the comfort and pleasure of passengers, who can enjoy a view of the landscape as it passes almost on a level with their eyes, instead of seeing, as they would from a height, a flat expanse of greens and browns, with none of that detail which makes the country pleasing to the eye.

A small non-rigid of the "S.S." type would, one imagines, make an ideal pleasure craft for a wealthy man. Costing probably no more than a small yacht, the owner would be able to take himself and a friend, with a mechanic to look after the engine, on short pleasure cruises of eight to ten hours' duration. A journey to Paris, for instance, could be undertaken with the utmost ease and comfort, while there seems no reason why in the future such small craft should not be capable of being moored out in the open, for a short period at any rate.

After a certain size is reached the non-rigid becomes impracticable, owing to difficulties in designing the rigging in such a way as to distribute the weights evenly over the envelope, and in this connection it is curious to note the almost universal neglect of the semi-rigid type, except in Italy.

Without going into details, there are many reasons for thinking that the ideal type of airship for a passenger-carrying service over a short journey, say, from London to Paris, will be found to be a semi-rigid, probably on the lines of the Forlanini, with a capacity of some half-million cubic feet.

Flying (London), January 2, 1918

The Development of German Aircraft.—The year of 1916 saw the inception of several small scouting biplanes approximating in general outline and characteristics to the various machines of this class used by the Allies. This type formed a drastic departure from customary German practice, and was undoubtedly introduced to meet the exceptional demands of air fighting. Those new scouts were engined with either Mercédès, Argus or Benz motors of 160 to 175 hp. While contemporary German practice was devoted to the type with swept-back wings and pronounced dihedral, these had straight wings of 30 ft. span and under; the upper plane was staggered forward, and they were also of the single-seater variety. The armament consisted of two fixed machine guns, firing through the propeller.

The chief improvements made on German airplanes during 1917 have been the perfecting of the small scout biplane, the gradual substitution of the six-cylinder 260 hp. Mercédès for the 240 hp. eight-cylinder model, and the production of big, twin-engined bombers of the Gotha, A. E. G., or Friedrichshafen class. During the latter part of 1917, a small, high-speed triplane scout has also appeared, and this may be taken as the German version of the highly successful Sopwith triplane.

Seaplane design and construction has not advanced to the same level as that of the land machine, the existing examples being mainly copies of pre-war British products. At least two examples of successful British seaplanes were in Germany before the war—a Sopwith bat-boat and a Wight seaplane, both fitted with 200 hp. Salmson motors. The machines produced intermittently since that period have all shown decided British influence, two types being very reminiscent of the Sopwith bat-boat and the Avro 100 hp. Gnome seaplane.

The average speed of German aircraft in August, 1914, was 70 m.p.h., the time taken for a climb of 3000 ft. varying from 5 to 15 mins. It appears from data available at that time that the fastest machine was the Halberstadt "Taube," 100 hp. Mercédès, with a speed of 92 m.p.h. The next best was the D. F. W., with 120 hp. Austro-Daimler engine, this accomplishing 85 m.p.h. It should be noted that a British machine of that period easily excelled these figures. Modern two-seater machines of enemy design, with engines of from 225 to 260 hp., are credited with speeds of 100 to 120 m.p.h. and a climb varying from 6000 to 7000 ft. in 9 mins. The pursuit or scouting type of machine equipped with the 175 hp. Mercédès engine has a speed of 110 to 125 m.p.h., but it should be remembered that ceaseless experimenting and the natural course of evolution is certain to produce improvements. It is impermissible to indicate the present performance of Allied aircraft, but it is already more than certain that the arrival of the right time will enable an account of unparalleled achievement to be recorded.

Flying (London), Dec. 5, 1917

Standardization of Petrol Gauze.—Considerable trouble and delay has been experienced in obtaining a regular supply of petrol gauze, primarily due to the fact that aircraft contractors depended upon importation for the finer mesh required for this very important accessory of aeronautical engines, and it was found that a wide variety of mesh was called for by different manufacturers, although they required the mesh for similar purposes, and in some cases it was very difficult to justify distinction. For instance, the difference in the width of the aperture between 200-mesh gauze and 180-mesh gauze is only 1/10,000 of an inch.

There has been a tendency to call for meshes much finer than are justified by the conditions. This has resulted in the use of a gauze which is much more fragile than is necessary or desirable.

To overcome this difficulty the Air Board took the leading manufacturers of wire-cloth into consultation, and the Royal Aircraft Factory experts made certain experiments which have resulted in a standardized gauze being agreed upon.

This will greatly facilitate manufacture, and will enable the material to be produced in Great Britain in adequate quantities to meet the demands from aircraft factories. The gauze will be known as "Air Board Standard Petrol Gauze."

Aeronautics (London), Dec. 12, 1917

Airship Crosses Mediterranean Sea.—In the light of future developments it is interesting to record that the Mediterranean in its full width has for the first time been traversed by an airship. It may be remembered that a previous crossing by airplane was made by Roland Garros, who on a Morane monoplane flew from Saint-Raphael to the African coast, passing over Corsica and Sardinia, on Dec. 18, 1912. On the present occasion the airship, a French one, left Paris and alighted at Aubagne, near Marseilles; continuing its journey thence it crossed the Mediterranean and landed safely at Algiers after a journey which occupied eleven hours. It is known that the French Government intends to establish a regular passenger service by airship between Paris and Algiers after the war. The present flight was evidently made in order to demonstrate the feasibility of the scheme, and its success augurs well for the future.

The Aeronautical Journal (London), Oct.-Dec., 1917

Commercial Aeronautics. By G. Holt Thomas.—A highly interesting anticipation of the possibilities of commercial aircraft in relation to the transit of passengers, mails and goods.

A Further Three Years' Flying Experience. By Captain B. C. Hucks.—A review of the development of the airplane in three years of warfare.

The Training of Aeronautical Engineers. By R. M. Walmsley, D.SC., F.R.S.E. and C. E. Larard, M.I.C.E., M.I.M.E.—An outline of a proposed course of instruction for aeronautical engineers.

News of the Fortnight

Surveyor General of Supplies Appointed

The Secretary of War announced on Jan. 25 the appointment of Mr. Edward M. Stettinius to the post of Surveyor General of Supplies in the office of the Director of Purchases. The latter office wase created by General Orders No. 5, of the War Department, dated Jan. 11, Col. Palmer E. Pierce of the General Staff of the Army being appointed Director of Purchases and detailed as an assistant to the Chief of Staff.

Four sections have been organized in the office of the Director of Purchases, namely:

Section of supplies, over which Mr. Stettinius, the Surveyor General, will preside.

The information and statistical section, with Dr. Leonard P. Ayres in charge.

The fiscal section, with Dr. Milo R. Maltbie at its head.

Section on organization and methods, with R. R. Montgomery in charge.

The Director of Purchases has the following assistants on his personal staff: W. F. Willoughby; Col. George H. Estes, General Staff; Maj. Guy Kent, General Staff.

Lieut. Col. Douglas I. McKay has been named as assistant to the Director of Purchases.

The British Air Council

The British Air Council, colloquially known as the Air Ministry, which was created by the Air Force Act, 1917, with the simultaneous unification of the British Air Services, has been established on Jan. 2 by Order in Council. The Air Council consists of a president and nine members, and is patterned after the general lines of the Board of Admiralty.

The Council is constituted as follows:

Lord Rothermore, Secretary of State and President of the Council.
Major-General Sir H. Trenchard, K. C. B., D. S. O., Chief of the Air Staff.
Rear-Admiral Mark Kerr, C. B., R. N., Deputy-Chief of the Air Staff.
Commodore Godfrey Paine, C. B., M. V. O., R. N., Master-General of Personnel.
Major-General W. S. Brancker, D. S. O., Controller-General of Equipment.
Sir William Weir, Director-General of Aircraft Production in the Ministry of Munitions.
Sir John Hunter, K. B. E., Administrator of Works and Buildings.
Major J. L. Baird, C. M. G., D. S. O., M. P., Parliamentary Under-Secretary of State.
Lieutenant-General Sir David Henderson, K. C. B., D. S. O., Additional Member of Council and Vice-President.

W. A. Robinson, C. B., has been appointed to act temporarily as secretary to the Council and H. W. McAnally to act as assistant secretary.

President Forbids Aircraft Expositions

By the President of the United States of America.

A PROCLAMATION

Whereas a state of war exists, and the military and naval forces of the United States are endangered by enemy aircraft, and

Whereas this danger will be increased by communicating to the enemy the present state of aircraft invention in the United States, and

Whereas the holding of so-called expositions of aircraft is a method of collecting and distributing information important to the enemy,

Now therefore I, Woodrow Wilson, President of the United States, by virtue of the authority vested in me by the Constitution and the laws of the United States, do hereby, for the protection of such forces, proclaim to all whom it may concern that, under the pains and penalties prescribed by the laws of war and the statutes of the United States, throughout the present war no exposition of aircraft shall be held in the United States or its possessions.

In witness thereof I have hereunto set my hand and caused the seal of the United States to be affixed.

Done in the District of Columbia this 1st day of January, in the year of our Lord 1918, and of the independence of the United States the 142d. WOODROW WILSON.

Fire Insurance for Aircraft

As a result of an inquiry conducted by the National Advisory Committee for Aeronautics into the subject of fire insurance for aircraft, it is found that most of the fire insurance companies are not writing or contemplating insurance for aircraft.

One large fire insurance company has announced that it is now prepared to issue such insurance. It appears, therefore, that other companies will take similar action, and that before long such insurance may be written generally.

Briefly, the new form of policy covers airplanes and seaplanes against fire arising from any cause while in flight or upon the earth, or upon any lake or river, or in or over the coastal waters of the United States, excluding Alaska, Porto Rico, etc. It will also cover the shipment of aircraft upon any railroad or other conveyance within the limits of the policy against burning, sinking, derailment or collision of the conveyance.

This insurance company advises caution in erecting buildings, and to avoid the congestion of hangars, which are usually remote from fire protection, and sometimes built close together; they should be separated by proper distances to the end that the burning of more than one hangar may be avoided. The separation of the units will also allow time for the removal of aircraft from endangered hangars.

Large Plant Runs with Auto Motors

A complete shutdown of the plant of the Dayton Metal Products Co. and a vital loss in the production of turnbuckles and tierods for fighting planes was recently avoided by the foresight and ingenuity of Secretary Hilton.

Several large plants in Dayton who are furnished power by the Dayton Light & Power Co. were closed Monday, Tuesday and Wednesday, Jan. 14, 15 and 16, because the power company was out of coal.

Hearing Saturday night that a forced shutdown was imminent, Hilton gave orders to remove from the company's trucks and passenger cars all the motors that could be spared. Seven motors were requisitioned. Six were installed at strategic points in the plant, while the seventh was held in reserve. The work was done Sunday and Sunday night by a force of garage men, carpenters and plumbers. Large gasolene tanks were also mounted.

On Monday morning with belts connected to main drives the automobile motors, with the help of a Fairbanks & Morse stationary gas engine, started to deliver the necessary power to keep the automatic machines going at full speed, and no loss in production resulted during the three days.

To run the plating department a Delco-Light engine was installed and run from several units of Delco-Light batteries.

The automobile motors used were two Packards, two old Speedwells, one 8-cylinder Detroiter and an Apperson. The old Apperson went to pieces one evening at five, but at six o'clock was replaced by the reserve motor.

Twenty-five oil heaters were also purchased as a preparedness measure. All the extra equipment will be held in reserve until the fuel situation becomes normal.

N. F. C. to Be Increased

A bill has been submitted to be introduced in Congress by Secretary of the Navy Daniels in regard to a temporary increase in the Naval Flying Corps. The bill (H. D. 847), which was referred to the Committee on Naval Affairs, asks that the authorized number of enlisted men of the Flying Corps be temporarily increased from 350 to 10,000.

Long Balloon Flight

A balloon carrying five army men from Omaha, Neb., landed at Sartell, Minn., making, it was declared on Jan. 3, a new army record for time and distance.

The balloon left Fort Omaha at midnight, Jan. 2, and landed at 9.15 o'clock the next day, approximately 550 miles away. Lieutenant McKinley was in charge.

Appointed to Joint Board

Lieut. Col. Thurman H. Bane, Signal Corps, has been appointed a member of the Joint Army and Navy Technical Aircraft Board, vice Maj. Harold S. Martin, Signal Corps.

Death of Edward M. Hagar

Edward McKim Hagar, prominent in business circles in New York and Chicago, and for some time president of the Wright-Martin Aircraft Corp., died of pneumonia at his home, 690 Park avenue, New York City, on Friday, Jan. 18. Mr. Hagar was born in Salem, Mass., on June 21, 1873. In 1893, when not yet twenty years old, and the youngest member of his class, he was graduated from the Massachusetts Institute of Technology. At the age of twenty-one he received his post-graduate degree of doctor of philosophy from Cornell University.

Edward M. Hagar
Photo by Notman

Mr. Hagar's first business experience was with a traction company in Chicago. Later he organized and conducted the business of Edward M. Hagar & Co., Chicago, which acted as sales representative for machinery manufacturers. A few years later he resigned in order to accept the managership of the cement department of Illinois Steel Co., Chicago. His rise was rapid, and when this company was absorbed by the United States Steel Corporation, Mr. Hagar was made manager of the Universal Portland Cement Co., the largest shippers of cement in the world.

He continued in the cement business until 1914, when the outbreak of the war impressed him with the tremendous possibilities of the airplane. In March, 1916, he was elected president of the Wright-Martin Aircraft Corporation, which was incorporated under the laws of New York, with a capital of more than $5,000,000. This company was a consolidation of the Wright Aeroplane Company, the Glenn L. Martin Aeroplane Company, the Simplex Automobile Company, the General Aeronautic Company, and the Empire Foundry Company.

In May, 1917, Mr. Hagar resigned to become president of the American International Steel Corporation, a subsidiary of the American International Corporation, which has offices at 120 Broadway, New York City; he was identified with this concern at the time of his death.

Mr. Hagar was a member of many clubs, including the Chicago, Union League, University, Onwensia, Chicago and New York Yacht Clubs, Recess, Riding, Engineers' Club of New York, and the Technology Club of New York, of which he was vice-president. He is survived by his widow.

Bragg Wins Curtiss Trophy

The Contest Committee of the Aero Club of America has awarded the Curtiss Marine Flying Trophy for 1917 to Caleb S. Bragg. Before he entered the competition he had promised, in case he won, to give the $1,000 in prize money to American aviators.

Mr. Bragg was asked by the Liberty Loan Committee of New York City to fly to Troy and distribute Liberty Loan literature on the way. The trip was made on Oct. 26, 1917, with Philip Beyer as passenger, from Port Washington, L. I. The machine used was a Wright-Martin seaplane.

The Curtiss trophy is valued at $5,000, and with it goes $5,000, to be divided equally into five annual prizes. It was first won in 1915 by Major Oscar A. Brindley, flying between San Diego and San Juan, California. In 1916 the trophy was won by Victor Carlstrom over a course from Newport News to Fisherman's Point, Va.

Sorenson With Curtiss

Clarence Sorenson, formerly of La Crosse, Wis., on Jan. 1 became assistant general superintendent of the Curtiss Aeroplane Co.'s new factory, according to an announcement. Mr. Sorenson will have under him fifteen superintendents.

Accessory Manufacturers Meet at Dayton

Business men do not usually expect to be entertained individually or in a body by large companies whose business they are soliciting. Nor do they expect to be taken through a large airplane plant and shown all the vital manufacturing processes. They are rather more accustomed to looking at the inside from without than the reverse. However, about seventy airplane accessory manufacturers had this novel experience recently.

The Dayton Wright Airplane Co. gave a dinner on Jan. 18 at the Dayton City Club to airplane accessory manufacturers of contiguous territory. Officers of the company also gave practically the whole day to entertaining their guests, whose welfare was looked after down to the details of railroad and Pullman tickets, hotel accommodations and automobiles for the twelve mile ride to the airplane factories, hangars and back to town.

One manufacturer, who at first had not grasped the underlying idea of the affair, said: " While I am curious, I am not quite sold on this. Here we are, a big bunch of outsiders invading a busy plant, working on the most vital feature of our war plans, wasting the time of officials and employees, and, in a good many cases, wasting our own time.

After the trip through the plants, dinner and speeches, this same individual expressed his new religion to a representative of AVIATION AND AERONAUTICAL ENGINEERING fervently and with no suggestion of other stimulation than the spirit of the meeting (in deference to visiting uniforms, it was a temperance affair). Said the convert: " I want to tell you, I have gotten something out of today. I have gotten this: I appreciate better the fundamental difficulties of airplane production. After listening to talks by Captain Hannay, R. F. C., Mr. Talbot, Major Vincent and Mr. Kettering, I have a pretty good mental picture of the whole proposition; on the physical side, actual inspection of a completed fighting machine and its manufacturing processes, and on the other, the man's part I must play as a manufacturer of an essential accessory; turning it out from the best materials, through the most exact workmanship, and just one jump ahead of 'faster than hell.'

" I know now where to go for information, and I know that I will get it if I go there.

" I know that it is up to me not to lay back and holler if a change in design is suddenly sprung on me, or if there is only one blueprint for a job that requires twenty. I know that the war is changing daily, that airplanes are still in a state of evolution, and that I can personally see to make a tracing and additional prints if they are needed.

" I appreciate that there will be no alibi for slow production in this war. We will either have to make good on American manufacturing methods or admit that Fritz is a better man. Nor can we pass the buck to the officers of the Aviation Section. The very immensity of the job of organization, or building up production from nothing, of getting a powerful engine, I now see is the main cause for such mistakes and delays as have occurred.

"The remarkable thing is that an organization which has had to expand 1000 per cent since we got into the war has made good to such a creditable extent.

"In other words, I am going back to my plant with a fresh reserve of that American commercial pep which ought to work just as successfully in putting over this war job as it has in building up the industries of my state."

To the visiting manufacturers unacquainted with Dayton methods the hospitality of the Dayton Wright company and the many courtesies extended came as a revelation. They felt that new vitality had been given to the much-abused terms, "cooperation and coordination." They left Dayton with definite knowledge of just how to weave those terms into a working day formula.

Major J. G. Vincent's talk at the dinner dealt with the development of airplane engines and the necessity of this country producing a high-powered engine which could be turned out in great quantities by American machine methods. He laid at rest persistent rumors as to the failure of the Liberty engine. Aviation and Aeronautical Engineering is in a position to emphasize and confirm the splendid performance records of this engine, and the fact that a steadily mounting number of complete engines are being turned out each week. The censorship does not permit of details being published of the first successful combined reconnaissance, combat and day bombing machine which is now in production.

Major Vincent told in detail just how the Liberty job had been accomplished. He told modestly, though convincingly, of his very important part in this work. He treated the entire matter as an engineering and manufacturing problem that had to be solved, and solved quickly. In plain, inornate language he told the technical story and how, through splendid cooperation, hard continuous work, and good luck, success had been achieved. He told, in another way, the story which, several months ago, was first told in exultant and overdrawn sentences, with the result that the sceptics, grown suspicious of official publicity, remained unconvinced. But none of the audience who heard Major Vincent's talk, who had seen the big Twelve in a fighting machine, and who had talked to aviators and mechanicians, remained unconvinced.

C. F. Kettering, vice-president of the Dayton Wright company, visualized for his audience the practical requirements for a successful airplane, how the fighting machine which his company was building had been adapted from foreign designs for the Liberty engine and to American quantity production methods, and the necessity for the accessory people to realize the vital part they must play. Kettering has a gift for presenting things forcefully, crisply and humorously. He knew his subject and his talk made a lasting impression, as it came from a man who is respected first for his ability as a production engineer.

The confidence inspired by knowledge on the aviator's part of the good workmanship and materials in his plane was the subject of a talk by Captain Hannay, R. F. C. He added the weight of his expert opinion as to the effectiveness of the Liberty engine and the excellent performance of the Combat machine, the first of which are being now produced, and which will later, he hoped, form a large part of our aerial effectives at the front. Captain Hannay's attitude was one of polite credulity as to what we were to do in the future, but he asked very earnestly that we do something quickly.

Orville Wright was expected, but was unable to attend, as the old injury to his leg was again giving trouble. The purposes of the gathering were explained by H. E. Talbot, Jr., president of the Dayton-Wright company, who also acted as toastmaster in introducing the speakers.

Those who attended follow:

At speakers' table were seated: H. E. Talbott, Jr., President, The Dayton Wright Airplane Co.; Captain Hannay, Royal Flying Corps; C. F. Kettering, Consulting Engineer, The Dayton Wright Airplane Co.; Major Vincent, U. S. Signal Corps; Frederick Patterson, Vice-President The National Cash Register Co.; H. M. Estabrook, President The Barney & Smith Car Co.; G. M. Williams, Assistant to President The Dayton Wright Airplane Co.; A. B. Hilton, Dayton Metal Products Co.; Thomas P. Gaddis, Secretary, The Dayton Wright Airplane Co.; R. O. Gill, Factory Manager, The Dayton Wright Airplane Co.; J. M. Schoonmaker, Jr.; Chief Engineer, The Dayton Wright Airplane Co.

The following guests were in attendance: J. C. Widman, J. C. Widman Co., Detroit, Mich.; Chas. Widman, J. C. Widman Co., Detroit, Mich.; J. N. Roberts, J. N. Roberts Co., New Albany, Ind.; A. D. Wilt, Jr., Schweppe & Wilt Mfg. Co., Detroit, Mich.; J. B. Clare, Schweppe & Wilt Mfg. Co., Detroit, Mich.; F. A. Chapman, Ypsilanti Reed Furniture Co., Ionia, Mich.; F. R. Eaglesfield, Kawneer Mfg. Co., Niles, Mich.; Mr. Preston, Goodyear Tire & Rubber Co., Akron, Ohio; Mr. Russon, Goodyear Tire & Rubber Co., Akron, Ohio; Griswold Wilson, General Rubber Goods Co., Cleveland, Ohio; L. H. Wallace, General Rubber Goods Co., Cleveland, Ohio; A. J. Jupp, The Lunkenheimer Co., Cincinnati, Ohio; M. L. Mitchell, The Robt. Mitchell Furniture Co., Cincinnati, Ohio.

J. A. Aull, The Lunkenheimer Co., Cincinnati, Ohio; L. E. Bauer, Dayton, Ohio; C. L. West, West Wood Working Co., Chicago, Ill.; W. L. Batt, Hess Bright Mfg. Co., Philadelphia, Pa.; W. F. Palmer, National Screw & Tack Co., Cleveland, Ohio; R. P. Troxell, W. H. Hoover Co., New Berlin, Ohio; C. W. Dickinson, General Fireproofing Co., Youngstown, Ohio; Mr. Ahlbrandt, American Rolling Mills, Middletown, Ohio; Mr. Duggan, Aluminum Co. of America, Cleveland, Ohio; J. Lloyd, Phillips Sheet & Tin Plate Co., Merton, W. Va.; W. P. Taylor, Lewis Spring & Axle Co., Chelsea, Mich.; A. N. Wilcox, Dayton Wire Wheel Co., Dayton, Ohio; R. E. Clingan, Hess Bright Mfg. Co., Philadelphia, Pa.; W. R. Brewer, Kellog Switchboard & Supply Co., Chicago, Ill.; H. W. Adams, Jr., Scovill Mfg. Co., Waterbury, Conn.; I. J. Mandel, National Lock Co., Rockford, Ill.;

Geo. Newbold, Aviation and Aeronautical Engineering, New York; J. M. Howett, Brightman Mfg. Co., Columbus, Ohio; J. T. Annas, Western Automatic Machine Screw Co., Elyria, Ohio; R. Oldfield, Western Automatic Machine Screw Co., Elyria, Ohio; J. T. Bowlus, Ridgley Trimmer Co., Springfield Ohio; Mr. Williams, Ridgley Trimmer Co., Springfield, Ohio; C. C. Koontz, Union City Body Co., Union City, Ind.; C. C. Attlespurger, Sedan Body Co., Union City, Ind.; Mr. Cheyney, Aluminum Co. of America, Cleveland, Ohio; Mr. Varney, Aluminum Co. of America, Pittsburg, Pa.; J. C. Turner, J. C. Turner Novelty Co., Dayton, Ohio; Bruce Ott, Maxwell Motor Co., Dayton, Ohio; J. C. Peil, Maxwell Motor Co., Dayton, Ohio; R. B. Dutch, Troy Mfg. Co., Troy, Ohio; C. C. Cross, Troy Mfg. Co., Troy, Ohio; R. R. Root, Globe Machine & Stamping Co., Cleveland, Ohio; Mr. Drosche, Turner Novelty Co., Dayton, Ohio; Wm. Kern, Turner Novelty Co., Dayton, Ohio.

F. W. Eggers, Eggers Veneer Seating Co., Two Rivers, Wis.; G. S. Hamilton, Hamilton Mfg. Co., Two Rivers, Wis.; A. J. Clampitt, Hamilton Mfg. Co., Two Rivers, Wis.; R. R. Newell, J. A. Roebling Sons Co., Cleveland, Ohio: Carl Loy, Columbia Steel Shafting Co., Pittsburg, Pa.; E. J. Ickes, Columbia Steel Shafting Co., Pittsburg, Pa.; H. G. Carnell, National Cash Register Co., Dayton, Ohio; M. E. Service, National Cash Register Co., Dayton, Ohio; J. H. Frankmer, National Cash Register Co., Dayton Ohio; F. A. McGee, Baldwin Co., Cincinnati, Ohio; Mr. Hinckley, Packard Agency, Dayton, Ohio; W. F. Thoms, Indiana Lamp Co., Connersville, Ind.; Frank Ansted, Indiana Lamp Co., Connersville, Ind.; F. A. Durnell, Keyless Lock Co., Indianapolis, Ind.; Fred Gennett, Star Piano Co., Richmond, Ind.; Harry Gennett, Star Piano Co., Richmond, Ind.; Mr. Frost, Superior Steel Corp., Pittsburg, Pa.; W. H. Kohler, J. A. Fay & Egan Co., Cincinnati, Ohio; Captain Newman, U. S. Signal Corps· Houston Lowe, Lowe Bros. Co., Dayton, Ohio; B. L. Lotz, Lowe Bros. Co., Dayton, Ohio; J. M. Graham, Lowe Bros. Co., Dayton, Ohio.

The following, connected with The Dayton Wright Airplane Co., were also present at the banquet and acted as guides during the tour of inspection: C. J. Sherer, H. A. Fitzjohn, R. H. Turner, H. K. Hamilton, C. H. Gosiger, O. F. Schmidt, H. S. Mathers, H. P. Wardwell, F. A. Ford, J. L. Primmer, A. P. Smith, E. Darrow, L. C. Luneke, H. F. Wygant and B. M. Shofstall.

The executive officers of The Dayton Wright Airplane Co. are: H. E. Talbott, chairman board of directors; H. E. Talbott, Jr., president; G. M. Williams, assistant to president; C. F. Kettering, consulting engineer; R. O. Gill, factory manager, and J. M. Schoonmaker, Jr., chief engineer.

EBRUARY 15, 1918

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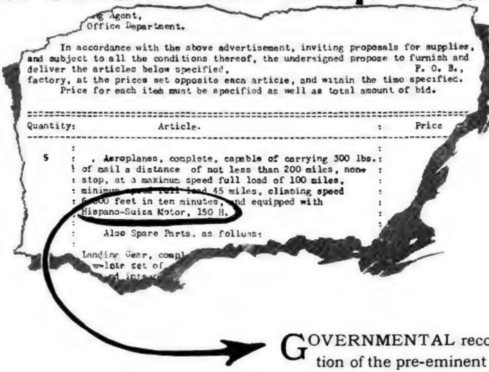

g Agent,
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Price for each item must be specified as well as total amount of bid.

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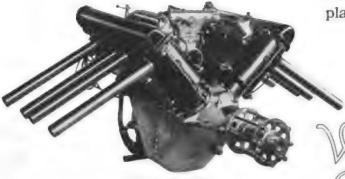

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Wright-Martin
Aircraft Corporation
New Brunswick, New Jersey

FEBRUARY 15, 1918 VOL. IV. NO. 2

AVIATION AND AERONAUTICAL ENGINEERING

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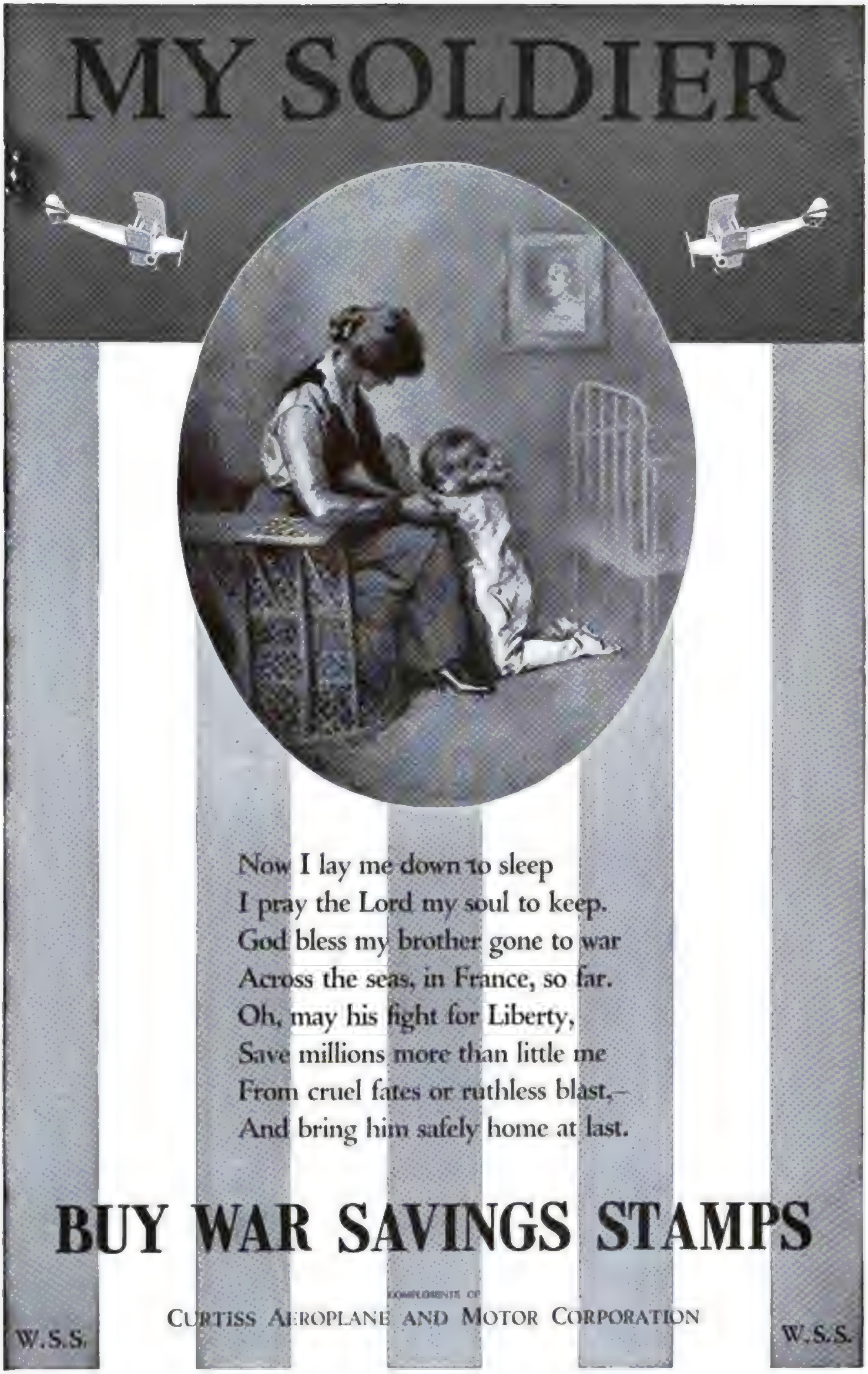

MY SOLDIER

Now I lay me down to sleep
I pray the Lord my soul to keep.
God bless my brother gone to war
Across the seas, in France, so far.
Oh, may his fight for Liberty,
Save millions more than little me
From cruel fates or ruthless blast,—
And bring him safely home at last.

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Vol. IV April 1, 1918 No. 5

Organized Airplane Spruce Production

By J. Frederic Thorne

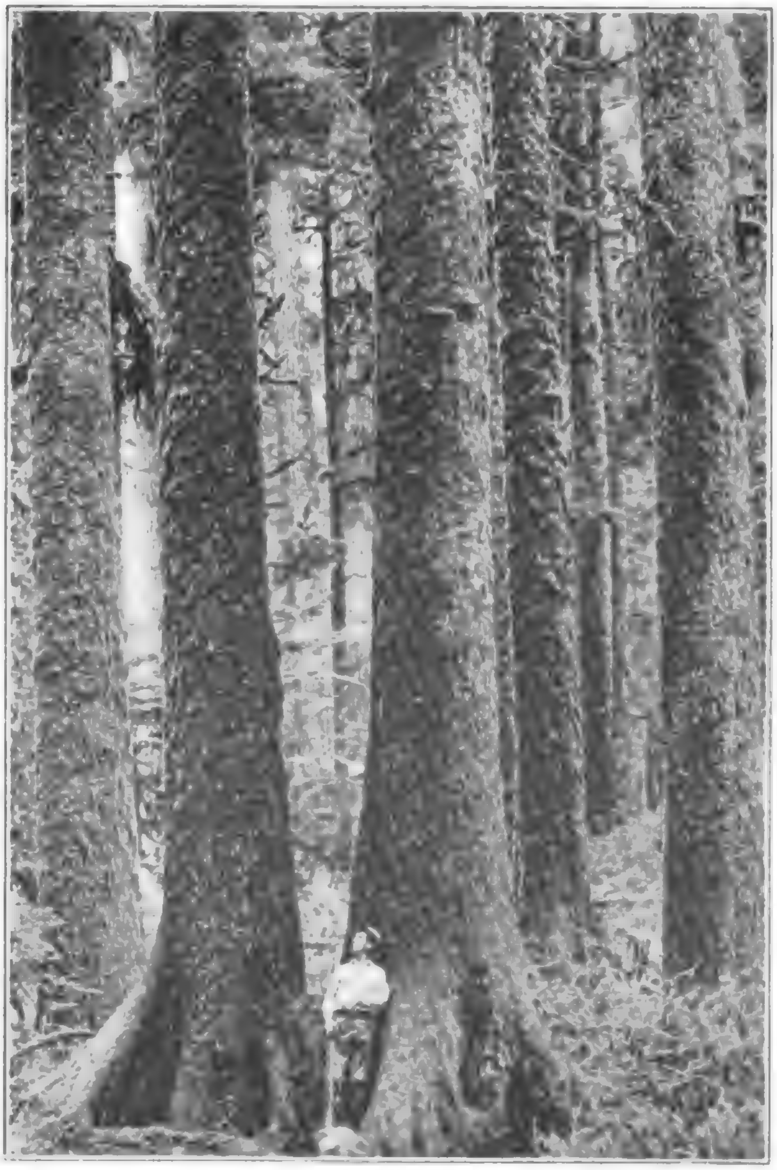
Portland Chamber of Commerce

Few people outside of army circles, and only a small number within, appreciate the immensity and importance of the undertaking signified by what is officially designated as "The Spruce Production Division of the Signal Corps of the United States Army." This is because it is new not only in its formation and activity but also in its conception and scope. Yet the organization and its work is the largest business venture of any kind ever attempted by the West.

The problem facing this business—and it is very strictly a business run along business lines—includes not only the military features incident to its army organization, but also industrial, manufacturing and transportation problems, each of which is a huge industry in itself and yet must be worked out to the smallest detail. It is a creation: nor has there been any precedent upon which to lay down even preliminary plans.

When Colonel Brice P. Disque, U. S. A., who is in command, took charge he was faced with chaos from which to evolve order. Here was a colossal logging operation with the spruce stands scattered over a coast line of two thousand miles and these stands representing only a small percentage of the timber in which they were located.

Here was an unprecedented condition of selection, operation and transportation, all to be put through at a speed never before required or thought of. The spruce production of the Northwest was in the hands of numerous companies and operators, small and large, working without the slightest relation to each other, in competition, and on a more or less hit and miss plan according to their individual needs or interests. The idea of pooling their efforts or coöperating in activities practically was unthought of.



Typical Stand of Spruce in Oregon
Photo Gifford and [illegible]

In addition to the commercial and physical difficulties Colonel Disque found the smoldering fires of a labor war, embers that constantly were blazing into flame here and there in the form of strikes, lockouts, shutdowns, bitter recriminations on both sides, sabotage and all forms of labor troubles that were incited and actively supported in all possible ways by a vicious pro-Hun element.

Colonel Disque's Problems

Colonel Disque had to fight the enemy without by producing spruce upon an enormous scale, and the enemy within by weeding out the enemy element that, for the moment, was placing a very serious handicap upon lumber production and threatening absolute paralysis of the entire industry. Coincidentally there was an insistent demand, amounting almost to a wail of distress, by the government for spruce, more spruce, and yet more spruce for the construction of airplanes.

The Spruce Production Division, while nominally a part of the Signal Corps, is in a way and in its operation an individual unit of itself formed for the one specific and definite purpose of producing the spruce demanded by the needs of the United States Government and its Allies.

There are now between ten and twelve thousand officers and men of the Army assigned to this division and attached to Vancouver Barracks, with the main administrative offices in Portland, Ore. The officers are, as a rule, men with previous timber or lumbering experience detailed from the various training schools and camps as well as from the regular army personnel. The enlisted men volunteered or were drafted from Oregon, Washington, Idaho, Montana, Michigan, Wisconsin, Maine and the timber states of the South-east. With very few exceptions they were practical lumbermen before their induction into the army, and those few exceptions were men picked for their special qualifications for the particular work they are doing. It is a division of experts. Any labor deficiency that arises or may occur is being supplied by details of soldiers in both camps and mills.

At the time of the formal opening of the Government spruce cut-up plant at Vancouver Barracks, Feb. 7, Colonel Disque, in addressing five thousand men of the Spruce Division troops, said in part:

"As a matter of history, I am going to tell you briefly what the spruce situation was in October. The production at that time was a little over two million feet a month, about one-fifth of what we required. Every logger, or practically all of them, was doing all he could to produce it, and the mills were sawing all they could obtain, as they were accustomed to sawing all kinds of lumber. To expand logging operations in the forests of Oregon and Washington even gradually is a large task, but to expand them to a point where they would meet the requirements of our government and its allies seemed an impossible task. The railway equipment, tracks and roads were not in existence, and it would have taken years to have obtained the required spruce by normal means.

"The only way out of it that I could see was to go into the forests and select the spruce and get it without the use of extensive railway equipment. That is what we started to do. We decided to rive or split selected trees and, having reduced the size of the pieces, it was a much simpler matter to transport it to the railway—furthermore the split timber had to run with the straight grain and that is just what we are after.

"We are now assured of a supply sufficient to keep ahead of our requirements. It is now past the experimental stage and the large increase in production has proven beyond question that it is the only way to supplement the normal industry's output. This does not mean that we do not want every foot that the ordinary operators can produce and all the mills can cut. All they can bring in we want, we have contracts for it and we will continue to buy and receive it."

Labor Troubles Discounted

He showed how critical labor conditions in the lumber camps when he took charge last Fall have been adjusted, better hours and working conditions obtained for the men, and their loyal coöperation obtained.

He showed how enough spruce has been contracted for and opened up for operation through the building of eighty-seven miles of railroad and construction of truck roads to supply present needs of the government and its future needs for eighteen months to come.

He showed how the overhead cost of spruce production has been reduced from $5 to $15 per thousand feet, the commission formerly paid Eastern brokers, to $1.34 per thousand feet.

He showed how production has been increased until in February twice as much spruce stock was shipped East as in November, and four times as much as in the month he took charge.

He showed how the production of desirable airplane stock was increased 11 per cent in February over January figures, through the work of a technical department, which is also improving the specifications.

He showed how the time it takes to move spruce from Oregon and Washington to the Atlantic Coast has been reduced, through the work of a traffic department, from fifty days to ten days.

He showed how the operation of the new cut-up plant for spruce at Vancouver, Wash., has already effected a saving of 75 per cent in the number of freight cars required to move the spruce East, a total of about 3000 cars a year.

Equipment Difficulties Removed

He showed how the Loyal Legion had been organized with 65,000 patriotic workers in both the spruce and fir production fields.

He showed how 10,000 volunteers for the work had been organized among the drafted men to help in spruce production as needed, and how 2000 of these men, all expert logging men, had been put in the camps since February 4, working the same hours and for the same pay as the civilian loggers, and under such circumstances that labor had not been antagonized.

Gigantic Problem Presented

One big difficulty in the way of increasing production 500 per cent, Colonel Disque explained, lay in the fact that of some 5,000,000,000 ft. of spruce timber in Oregon and Washington, not more than 200,000,000 ft. will meet the rigid requirements of straight grain airplane spruce.

"If we took the 5,000,000,000 ft. and brought it in here," said he, "we couldn't get rid of it. It would swamp us. So we decided that the only sensible, intelligent thing to do was to go into the woods, select the trees meeting the requirements for airplane spruce, split them up then and there and take the pieces out."

In order not to interfere with operations of big crews, closer in, Colonel Disque said, it was necessary to go into the more remote districts, to build a few miles of railroad and some truck roads to bring out rived spruce after the trees had been selected and rived.

He declared that the mills of Oregon and Washington were not equipped to cut spruce to meet airplane requirements, and demonstrated how rigid the specifications must be by showing them pieces of sawed spruce that appeared to meet requirements, but had split because not cut properly. Therefore, he explained, it had been necessary to build the cut-up plant at Vancouver and to bring the rived spruce there.

"One result from this cut-up plant already has been a tremendous saving in the number of freight cars required," he emphasized. "When we came here, it took about 2000 ft. of specification 1 spruce to make one airplane. Now it takes only 400 ft., which saves 75 per cent in the number of cars required to ship it East, or 3000 cars a year."

Colonel Disque told how in taking "the extreme measures" he had ruthlessly cut away a lot of red tape, had taken steps that encroached on the law, and had smashed all kinds of Army precedents. But it had to be done.

The labor situation when he took charge was described as being "very critical." Today the workmen are satisfied and are working under better hours and conditions. He told of the organization of the Loyal Legion, and what a success it has been.

Labor Unrest at End

"Our attempt has been to stabilize the labor situation," he said. "And today we are sending out all the spruce they can use, and more."

In answer to a question, Colonel Disque said that Oregon and Washington are furnishing virtually all the spruce for the airplanes of both the United States and its Allies, a very small proportion of the output coming from British Columbia, New England and the South. All these sources of supply put together were negligible, he said. He explained that the Allies take 60 per cent of the Northwest's output, and the United States 40 per cent.

Details of the arrangement made in establishing the basic eight-hour day, carrying with it prescribed working conditions and wage scales, were announced in a bulletin issued by Colonel Disque. More than 62,000 employes in the woods and mills, members of the Loyal Legion of Loggers and Lumbermen, are affected by the officially promulgated order, applicable to the War Department's program for maximum production of lumber in Western Oregon and Washington to win the war. With the issuing of the bulletin announcement was made that the government's bonus for rived spruce has been extended to June 30. The bulletin follows:

Official Bulletin

1. -The undersigned, having been authorized by unanimous vote of the representatives at a convention of the logging camp and lumber mill operators, and also by a convention of delegates representing 62,000 members of the Loyal Legion of Loggers and Lumbermen, to determine what will be conducive to a maximum production of material necessary for our war program, both in airplane stock and ship material, and to that end to determine certain questions regarding labor conditions in the logging and lumber industry of the states of Oregon and Washington west of the Cascade mountains, the following decisions are published and strict compliance of operators and employes is enjoined.

2.—It is decided that the entire industry, logging camps and lumber mills, adopt the basic eight-hour day principle as of March 1, 1918, with the understanding that time and a half be paid for overtime when men are worked more than eight hours, except as hereinafter provided.

3.—It is further decided that all employes shall work actually on the job a full eight hours each of six days per week and that no camp or mill shall work a crew more than eight hours, producing its product, nor more than six days per week. This does not prohibit working two or three shifts per day of eight hours each.

4.—The following schedule represents as near as can be determined the average of all wages in the industry. It must be realized that conditions of operation, location, etc., have for years made it necessary that there be a variation in this schedule for different camps:

Blacksmith	Optional
Blacksmith's helper, per hour	$.40
Brakeman, head, per hr.	.60
*Brakeman, second, per hour	.55
Bucker, per hour	.55
Bucker, head, per hour	.60
Bucker, winfall, per hour	.55
Bucker, wood, per hour	.45
*Camp helper, per month	90.00
Chaser, per hour	.55
Chokerman, per hour	.55
*Cook	Optional
*Cook, second, per month	100.00
Drum tender, per hour	.45
*Engineer, donkey, per hour	.60
*Engineer, duplex, per hour	.60
*Engineer, locomotive	Optional
Faller, head, per hour	.60
Faller, second, per hour	.55
Filer, head, per hour	.65
Filer, second, per hour	.60
*Fireman, donkey, per hr.	.45
*Fireman, locomotive, per hour	.40
*Foreman, grade	.45
*Foreman, section, per hour	.45
*Foreman, truck, per hr.	.45
*Head handy man, per hour	.65
High climber, per hour	.80
Hookon man, per hour	.55
Hook tender, per hour	.90
Knotters, per hour	.45
Loader, head long log, per hour	.75
Loader, head short log, per hour	.65
Loader, second long and short, per hour	.55
Log. R. R. Man (construction) per hour	.40
Machinist	Optional
Main line section men, per hour	.35
*Pump man, per hour	.45
Rigger, head, per hour	.65
Rigger, second, per hour.	.55
Rigger, third or helper, per hour	.55
Rigging slinger, per hour.	.55
C. O. rigging man, per hour	.55
Signal boy, per hour	.40
Skidroad man, per hour.	.45
Sniper, per hour	.50
Spool tender, per hour	.45
*Superintendent	Optional
Swamper, per hour	.45
Unhook man, per hour	.55
*Waiter and dishwasher, per month	95.00
Wood splitter, per hour	.45
*Wood's foreman	Optional

5.—In order that employes may meet the conditions peculiar to their own camps they are authorized to increase the hourly wage in the case of any employe up to, but not exceeding, 10 cents per hour over the above schedule. This must not be understood as approving of a general horizontal increase because certain men and certain jobs will always be worth more than others.

No Wage Reduction

6.—There will be found a few exceptional cases where men have been receiving daily wages higher than authorized by this bulletin. Many operators have recommended it, such men as were employed, actually or in suspension, on February 25, may continue to receive such higher pay upon approval of this office of lists to be submitted at once by employers of such men—it being the fundamental idea of this office that no man shall have his old 10-hour daily wages reduced as a result of the adoption of the basic eight-hour day.

Loading Spruce on Way to the Cut-Up Plant
Photo Gifford and Prentiss

7.—Men marked by an asterisk (*) must be considered as daily employes who are not entitled to extra pay for work in excess of eight hours, which is ordinarily and customarily performed to insure continued operation of the plant. Their pay contemplates such service, and no extra pay will be allowed.

8.—Men when engaged in necessary repairs, moving, construction, fighting fires or other emergency, working beyond the eight-hour day or on Sundays, as well as railroad crews when operating trains in connection with such service, will receive straight time for such extra work.

9.—The following maximum pay of certain employes in sawmills should be considered as the greatest to be paid, and in no way as a standard:

Car loader (equivalent rate per M) per hour.	$.50
Carriage man, per hour	.47½
*Cook	Optional
*Assistant cook, per month	100.00
Dogger, per hour	.50
Edgerman	Optional
Assistant edgerman, per hour	.50
*Engineer, chief	Optional
*Engineer, helper	Optional
Filer, band	Optional
Filer, circular	Optional
Filer, assistant, circular	Optional
*Fireman, head, per hour	.47
*Fireman, assistant, per hour	.45
*Foreman, all	Optional
Grader, per hour	.55
Laborer, per hour	.45
Log deck, per hour	.52½
Millwright, per hour	.67½
Assistant millwright, per hour	.57½
Offbearer, per hour	.50
Oilers, per hour	.52½
Filer (or equivalent rate per M) per hour	.50
Planer feeder, per hour	.52½
Planer trimmer, per hour.	.50
Resawyer, per hour	.60
Setter, per hour	.55
Tallyman	Optional
Trimmerman	Optional
Assistant trimmerman, per hour	.50
*Waiter and dishwasher, per month	95.00

10.—Probably no mill pays all their employes the amounts stated, but certain men in certain mills under their special conditions earn the scale as written and it is therefore established as a maximum scale for the designations stated. It must not be expected that this maximum will be paid in all mills or in all positions.

11.—There will be found a few exceptional cases where men have been receiving daily wages higher than authorized by this bulletin. Many operators having recommended it, such men as were employed, actually or in suspension, on February 26, may continue to receive such higher pay upon approval of this office of lists to be submitted at once by employers of such men, it being the fundamental idea of this office that no man shall have his old ten-hour daily wages reduced as a result of the adoption of the basic eight-hour day.

12.—Men marked by the asterisk (*) must be considered as daily employes who are not entitled to extra pay for work in excess of eight hours, which is ordinarily and customarily performed to insure continued operation of the plant. Their pay contemplates such service and no extra pay will be allowed. Also it must be understood that men operating machines must tune them up before or after the eight-hour day and such work is not overtime.

13.—Men engaged in making repairs and construction work, teamsters, chauffeurs, transportation men, loaders, graders and tallymen when required for work necessary to the continued eight-hour production of the product, shall receive straight time for such period worked in excess of eight hours.

No Overtime Work

14.—It is not the intention of this office to authorize any overtime work in general operation, and if production must be increased, additional sides or shifts must be established.

15.—No employer will furnish, gratis, transportation to or from place of employment for an employe. This does not prohibit advancing the cost of a railroad or boat ticket, which amount shall be deducted from the first pay due a man.

16.—Certified copies of the schedule in each camp and mill will be filed with this office as of the 30th of each month, not showing names of employes, but designations, alphabetically arranged as printed above with wages paid for that month.

17.—It is further decided that no employe except the cooks, shall receive free board, and that a uniform charge of $7.25 shall be paid by all employes, except cooks, for their weekly board. That cost shall include food and preparation as well as utensils and equipment, and wages of kitchen and dining room employes.

STARTING TO FALL A GIANT SPRUCE
Photo Gifford and Prentiss

18.—It is further decided that all employers who furnish housing accommodations for their men arrange at the earliest practicable date to supply clean bedding, including beds, mattresses, pillows, blankets, sheets and pillow slips to all men employed and that a charge of $1 per week be made for the service, the charge to be at the rate of 25c per day for each of the first four days of each week. The service shall include change of sheets and pillow slips weekly or oftener. Where the majority of the employes of any company agree this provision may be dispensed with.

19.—Men employed in camps or mills at work which does not come within the designations printed above will be paid such pay as is mutually agreed upon between employer and employe.

20.—It is recommended that wages be paid to employes every two weeks.

21.—This corrected bulletin is made necessary because of natural development of the problem. Every point has been carefully and conscientiously considered. Possibly other changes of minor importance may be necessary. It must be kept constantly in mind that this office is the neck of the funnel for all ideas, facts, information and conditions and that every decision will be made after mature consideration.

22.—It is requested that employers and employes co-operate to the limit in eliminating all technicalities and petty contentions. Trivial questions must be overlooked and serious ones submitted to this office for relief. This office expects no reduction in production and a spirit of "pull together" to justify the action already taken.

23.—The life of your nation and the safety of the world is largely dependent upon the future performances of the men interested in this bulletin and reduction of production by wilful neglect on the part of either employer or employes in any camp or mill in the lumber industry in the Pacific Northwest is no less treason than would be a strike or disobedience of orders among soldiers or sailors. Just claims of employers and employes will arise, but a fair and just means of solving them has been found and a square deal is guaranteed. In the future no one will be allowed to block the lumber requirements of our country.

Loyal Legion Organized

The pro-Hun propaganda and activities have been met and offset by Colonel Disque through the formation early last December of an organization known as the Loyal Legion of Loggers and Lumbermen, which is, in reality, an industrial army and adjunct to the Spruce Division. This Legion now numbers over 62,000 members, employes and employers, in the spruce and fir camps of the Pacific Northwest getting out lumber for the needs of the nation. The organization is bound together solely by a fervid spirit of patriotism that has been found fully sufficient as an indissoluble bond. There are no dues, nor, in the ordinary sense, any compulsory restrictions or by-laws. The men are loyal Americans banded together for the prosecution of one of the most important industries of the war program, men who need no oath or other compulsion to do their utmost of patriotic endeavor. Individually and collectively they realize that they are performing a service fully as important and worthy of as much honor as the men in the front line trenches.

Almost immediately upon the formation of the Legion both the open and hidden enemies suffered complete defeat; sabotage and slacking have utterly disappeared except for an occasional individual attempt to blow the cold embers of sedition into life again. When these sporadic attempts occur they are met with full and swift suppression.

It is Colonel Disque who says how long the men shall work and how much they shall be paid; what the living conditions of the camp shall be, what the employers must provide and what the workers shall supply. There will be no more labor troubles in the lumber camps of the Pacific Northwest where the Loyal Legion is in operation.

In one instance, the men threatened an instant strike because two men refused to join the Legion and trouble was averted only by the discharge of the two employes.

The Government's Demands

The government now is demanding for airplane production 11,000,000 ft. of spruce per month. It must be remembered that this is not the gross cut but represents only about 15 per cent of the log, the airplane specifications calling for only the highest and best part of the logs. Great as is this demand, it is said that the Northwest section easily can meet it for the next three years without any difficulty, and, if necessary, probably could duplicate the supply.

The commandeer order of the government which gives the Spruce Production Division of the United States Signal Corps authority to take spruce suitable for airplanes wherever located and by whoever owned adds interest to a survey of available spruce in Oregon and Washington which has just been made by the United States forest service as follows:

"An inventory of the Sitka spruce stumpage of Washington and Oregon, recently made by the forest service, indicates that there are about 11 billion feet of this timber within the spruce belt of these two states. This inventory was undertaken under the direction of District Forester Cecil for the use of the Spruce Production Division of the Signal Corps, that there might be available positive data as to the amount and distribution of all the possible airplane material."

Data of Public Record

The data were secured largely from county records, but have been supplemented by many private cruises which were patriotically furnished by the timberland owners for this purpose. The records so obtained have been presented on cards—a single card for each section—upon which the estimated stand on each 40, the name of the owner, timber quality, etc., are entered. In this card index from this large mass of detailed information is convenient for use.

The summary of this detailed data shows the following amounts of spruce for each of the counties in the spruce belt:

WASHINGTON	Ft. B.M.	
Clallam county	2,187,000,000	
Jefferson county	2,182,000,000	
Grays Harbor county	775,000,000	
Pacific county	959,000,000	
Wahkiakum county	161,000,000	
Whatcom, Skagit, Snohomish, King, Pearce and Mason counties	311,000,000	
		6,575,000,000
OREGON	**Ft. B.M.**	
Clatsop county	1,287,800,000	
Tillamook county	936,500,000	
Lincoln county	900,000,000	
Lane county	100,000,000	
Douglas county	682,000,000	
Coos county	468,000,000	
		4,374,300,000
Total for Washington and Oregon		10,949,300,000

The majority of this spruce is held in private ownership. In Oregon the amount of government stumpage is very small and the amount that is accessible is negligible. In Washington there is about 600,000,000 ft. on the Quinault Indian reservation (in Grays Harbor county), and 950,000,000 ft. on the Olympic national forest (about equally divided between Clallam, Jefferson and Grays Harbor counties); of this only a very little is now near enough to transportation to be a factor in the spruce production campaign.

Alaska Timber Averages Lower

In Alaska there are between 15,000,000,000 and 18,000,000,000 ft. of Sitka spruce, but less than a billion feet of this are thought to be of a quality to yield airplane stock.

Because of the absence of county cruises, or for other reasons, the estimates for Tillamook and Douglas counties are not complete, but are based on private cruises for part of the territory only. They include, however, all the main bodies of spruce, or those which are known to be of good quality. There is some additional spruce not included in the table, which occurs in scattered stands or is of too poor quality to be worth considering for airplane purposes.

The estimate for Lane and Lincoln counties had to be based on general knowledge of the forests of the region in the absence of many detailed cruises.

The 11,000,000,000 ft. in Washington and Oregon have been classified as a matter of interest, as follows:

Four billion feet are reasonably accessible at the present time or could be made accessible by short extensions of existing transportation routes.

Two and one-half billion feet are in large bodies, so inaccessible at present that extensive construction would be necessary to reach it.

Three and one-half billion feet are either in scattered inaccessible stands, or consist of rough, low grade timber.

Small Part Airplane Stock

Though the gross amount of stumpage looks large, it must be remembered that not every tree will produce airplane lumber, and the best of them but a small percentage. The entire 4,000,000,000 ft. that are considered reasonably accessible, therefore, could, under the most efficient manufacture, be expected to yield only two or three hundred million feet of acceptable airplane lumber.

Port Orford cedar is now being used in airplane construction, and Oregon is the source of supply for this timber. The available suply is limited to Coos and Curry counties. In the former county the inventory of the privately owned timber shows 250,000,000 ft.; in Curry county there is probably as much more; and in the Siskiyou national forest, in government ownership, another 250,000,000 ft. of cedar.

The requirement that the spruce used for airplane be cut with and not across the grain, not only reduces the proportion of a log that can be used, but also calls for the highest skill in sawing. To obviate some of this difficulty, to reduce wastage and to lessen the necessary transportation from the woods to the mills, rived or split spruce is being used to a considerable degree, since this allows of sorting and grading in the woods. The selection of clear, straight grained trees is, of course, most important, requiring good judgment and careful consideration. After the timber is felled and bucked to the desired lengths, logs are jacked out and the splitting started at the small end of the log. Seven or eight pound steel wedges are used, lined perpendicular down through the center of the log and placed about eight inches apart. After the steel wedges have cracked the log the entire distance across the end, wooden edges are driven for the completion of the operation.

"BUCKING" SPRUCE FOR AIRPLANES
Photo Gifford and Prentiss

The Model C.V Albatros Biplane

Among the enemy airplanes which have more recently been captured on the Western front by the Royal Flying Corps and are now on exhibition in London, a two-seater fighter, the Model C.V Albatros biplane, elicits considerable attention.

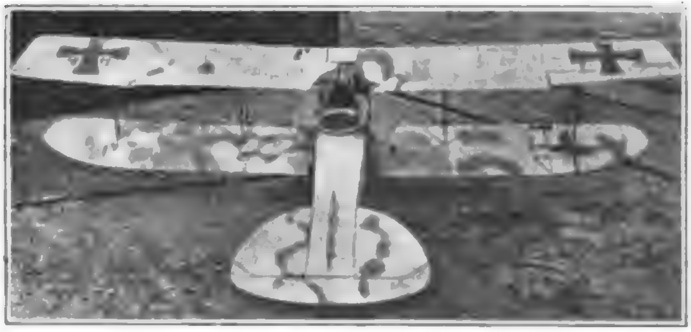


FIG. 1. REAR VIEW FROM ABOVE OF THE ALBATROS C. V.

This machine, which is here described and illustrated after *Flight*, proves of particular interest as a specimen of modern German airplane construction, because it tends to show that some, and not the least well known, enemy airplane designers are displaying a growing sympathy toward the use of veneer in body construction.

The German C-series airplanes are generally termed "all-purpose" machines, because they are used for reconnaissance, fire-control, fighting and tactical bombing. This tendency to use a machine for various functions is distinctly German, being at considerable variance from the French leaning at specialization.

Aerodynamically, the Albatros to be dealt with in what follows is, perhaps, chiefly interesting on account of the evident attempt on the part of the designer to provide as good a stream-line body as is possible, having regard to such external fitments as machine guns, etc., which naturally detract, to a certain extent, from the efficiency of the lines of a body of a modern two-seater, where the gunner frequently has to stand up, with the upper portion of his body projecting above the body covering. This effort at stream-lining is particularly noticeable in the nose of the machine, where the aluminum cowling over the engine is carried right across, leaving only the exhaust collector exposed. In front of the covering of the body proper is a cowl shaped as a truncated cone, which serves to enclose the nose and reduction gear of the engine, and to carry the lines of the body into those of the "spinner" around the boss of the air screw. The sides of the body, from a short distance behind this cowl to the tail, are flat, as is also the bottom, but the top of the fuselage is covered with a curved covering of three-ply.

At the rear the body terminates in a horizontal knife edge, an easy flow being provided for the air by running the top covering of the body into the three-ply covering of the fin in a smooth curve. Similarly, the fixed tail plane, which is of a symmetrical section and very deep, has its top surface practically in continuation of the top covering of the body, presenting no great and abrupt changes in curvature. The total effect is one of the extremely smooth and easy-flowing curves, and the body resistance cannot be very great in proportion to the cross sectional area of the body. We have no figure of the actual resistance coefficient in the formula $R = kAV^2$, but are inclined to imagine that the coefficient k has quite a low value.

As regards the rest of the machine, the Albatros designer does not appear to have been so careful in cutting down resistance. For instance, the wings have the usual circular section stranded cables for taking lift and landing stresses, and no attempt appears to have been made at stream-lining these.

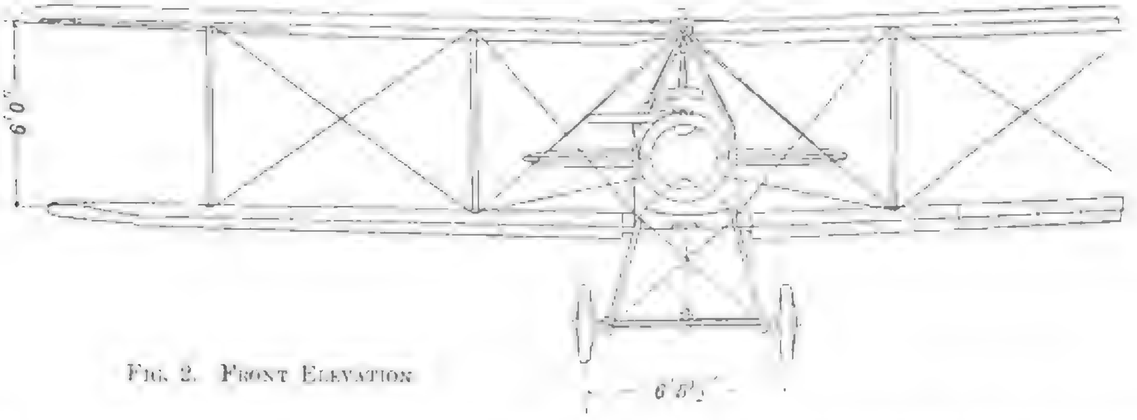


FIG. 2. FRONT ELEVATION

Constructionally, the Albatross shows much that is of interest, chiefly in the construction of the body, but also in other respects. Fundamentally, the Albatros body construction is that employed in building light boats and hydroplanes. There is a light framework, consisting of four main rails at the corners of the rectangular section body, two auxiliary rails somewhere about halfway up on the sides, and bulkheads or transverse partitions of varying shape and thickness along the body at intervals. The whole is then, as in boat building, covered with a skin of ply-wood, in this case three-ply. Regarded as a compromise, this form of body construction would appear to be quite good. Without entailing the time and expense of the true monocoque body, it provides a reasonably good stream-line form. As a manufacturing proposition, it is probably about equal to the girder type of body, while it has the advantage of not requiring any truing up in the erecting process, this following automatically when making the parts over jigs and formers. One advantage this form of body does appear to possess, although to a somewhat lesser extent than the true monocoque—shell splinters and rifle and machine-gun bullets are less likely to damage it seriously than is the case with the girder type. In the latter, should a longeron be shot through, nearly all the strength of the structure is gone, whereas this semi-monocoque structure would retain its strength even after damaging some of the longitudinal members.

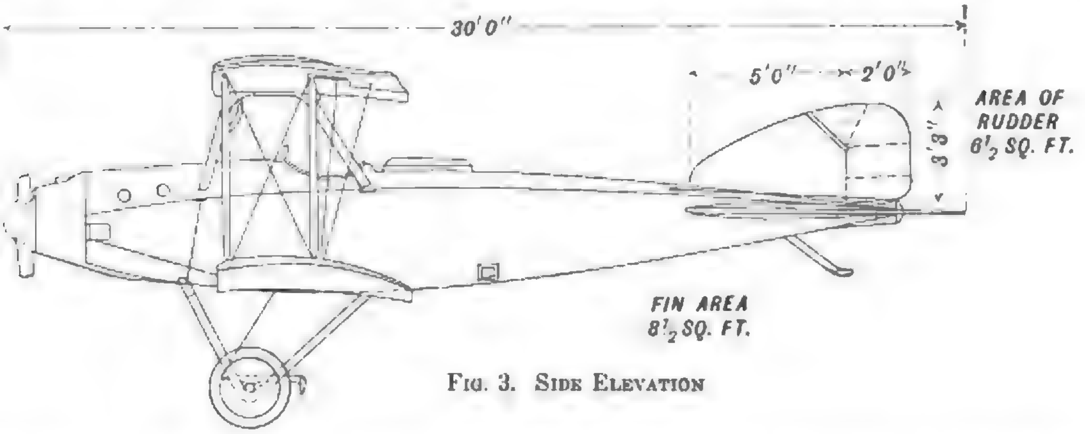


FIG. 3. SIDE ELEVATION

Finally, there is the question of strength for weight. We have no data relating to tests of such a structure carried out by our authorities, although possibly such tests may have been, and certainly should be, made. But in its issue of April 4, 1914, *Flight* published particulars of an Albatros biplane which was brought over to England and flown there by Thelen, which had a body fundamentally similar to the one at present under discussion, although differing from it in minor details. At the time details were furnished of tests carried out on an Albatros body of this type by the Deutsche Versuchsanstalt für Luftfahrt, according to which the factor of safety of the Albatros body was about 60, and the resistance to bending 2.5 times greater than that of a diagonally wired body of the same outside dimensions, and having members of the size usually employed in structures of this type. The Versuchsanstalt also stated that the Albatros firm were justified in concluding that the bending resistance of the veneer type of body is greater than that of a cross-wired body of the same weight, although no actual figures were given showing how much greater.

When looking into the detail construction of the Albatros body, the first thing that impresses one, apart from the absence of internal cross bracing, is the extensive use that has been made of ply-wood in the construction of the transverse bulkheads or formers, which take the place of the struts and across members of the girder type of body. In Fig. 5 are shown the different bulkheads of the body, with dimensions, etc. The rail, halfway up the sides of the body, is placed parallel with the propeller shaft, thus serving as a datum line from which to make measurements of distances and angles.

In order to enable our readers to better form a conception of the Albatros construction, we have shown, in Fig. 5, half-sections of the more important and representative bulkheads. In the front portion of the body the bulkheads, which here have to take the weight of the engine, are about 1¼ in. thick, and are made up of a number of laminations of wood, which are, of course, so placed in relation to one another that the grains of adjacent layers run at angles to one another. It was further noticed that in making up these bulkheads whole sheets of the different woods were not always employed. On the contrary, many of the layers appear to have been shouldered or spliced, being made up of comparatively small pieces. It is possible that this has been done with a view to utilizing pieces of wood that would otherwise have had to be scrapped.

On the other hand, it may have been done to increase the amount of crossing of the different grains. In any case, it would appear to serve both purposes, although one would expect the time taken in manufacture to be somewhat increased by such careful fitting together of small pieces of wood.

Fig. 7 shows the nose of the Albatros, and clearly indicates the method of supporting the engine. The first bulkhead, it will be seen, is solid, and is at right angles to the propeller shaft. The second bulkhead (No. 2, Fig. 5) is lightened by piercing, as shown, and is also vertical, while the third engine support is formed by a solid bulkhead (No. 3, Fig. 5), which slopes back so as to support the front chassis struts and front cabane struts at its lower and upper ends respectively. As the front engine support is clearly shown in the sketch, Fig. 7, it has not been included in Fig. 5. The bulkhead (No. 1, Fig. 5) is merely a former, and does not help to support the engine bearers. These are of I section spruce, and have plywood flanges applied on top and bottom. The upper flange is continued outwards to the middle longeron so as to form a shelf or bracket at the sides of the engine.

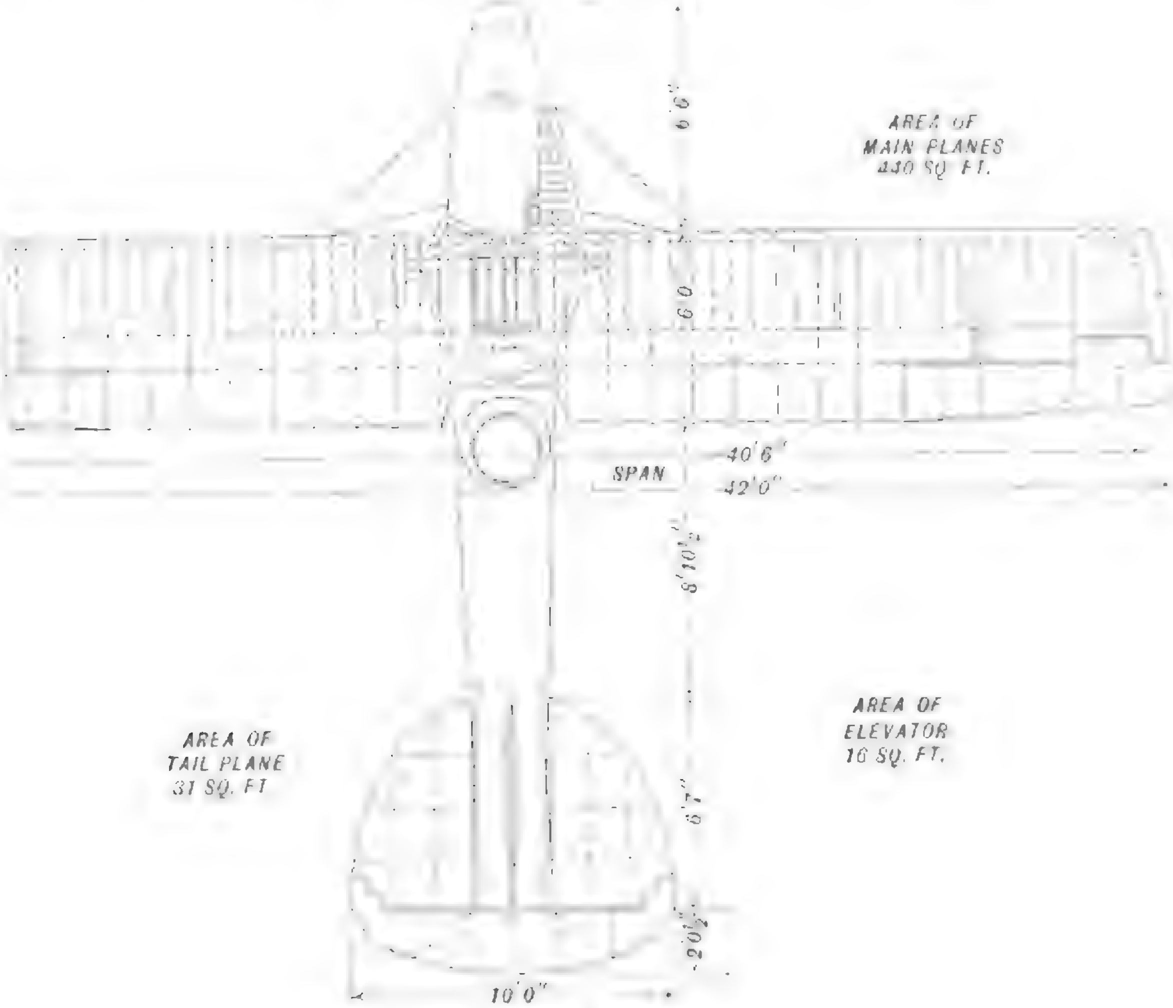


Fig. 4 Plain View

A construction somewhat different from that of the engine supports is employed in the panel between the pilot's and gunner's cockpit. This consists (No. 4, Fig. 5) of a spruce framework faced each side with 3 mm. three-ply, the whole having a thickness of 26 mm. (about 1 in.). Behind the gunner's cockpit is a light partition built up as shown in 5, Fig. 5. Two

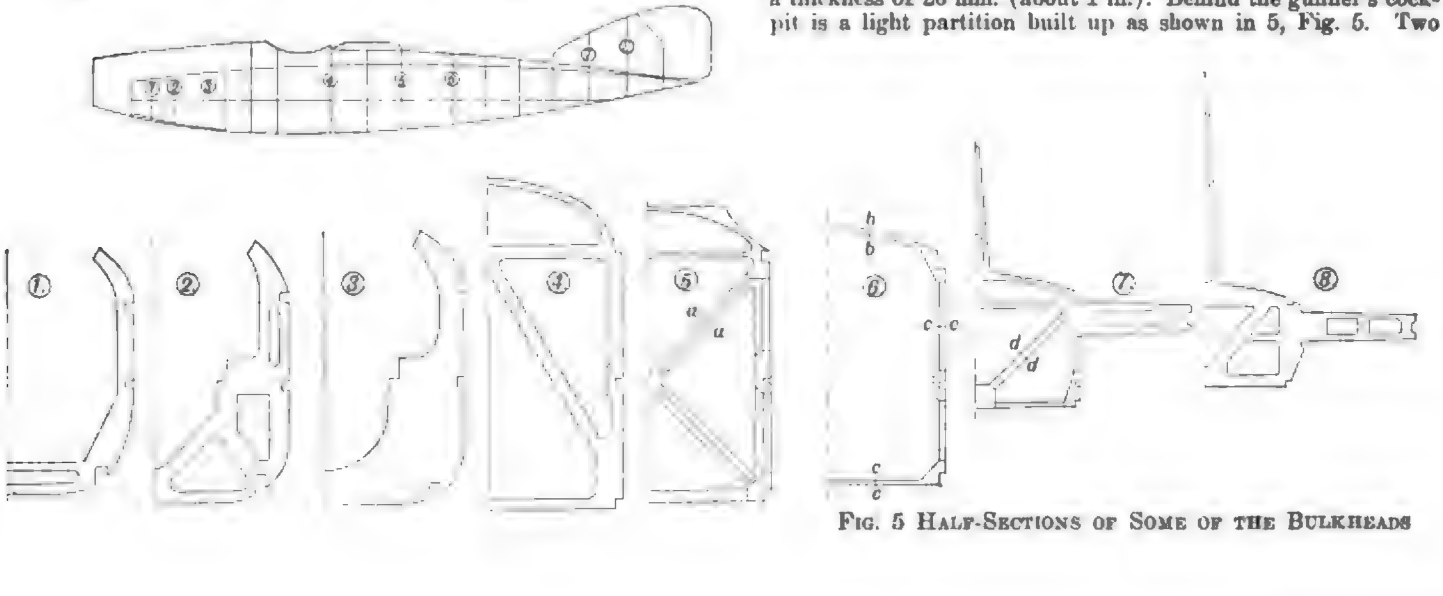


Fig. 5 Half-Sections of Some of the Bulkheads

light spruce struts run diagonally across from corner to corner of the body, crossing in the center of the fuselage, at which point they are reinforced by three-ply facings and triangular blocks glued into the corners.

Their attachment to the upper and lower body longerons is of a similar construction, and will be clear from the diagram. On their front faces these diagonal struts are provided with a 2 mm. flange to stiffen them against buckling. A canvas curtain is secured to the front of the partition, having in it pockets for maps, etc.

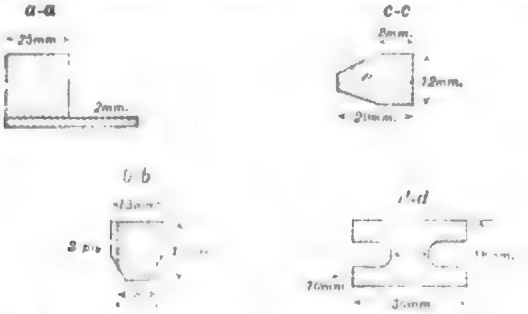


Fig. 6. Dimensions of Sections of Fig. 5

From this point back to the point where the tail plane and vertical fin are attached, the formers of the body are in the nature of a very light framework of thin struts, a typical one being shown in 6, Fig. 5. The general construction and some of the dimensions of the various members will be clear from the illustration.

One of the features in which the present Albatros differs from previous types is the construction and attachment of the tail plane and vertical fin. The latter is covered with three-ply, and is made integral with the body, out of which it grows, so to speak. The construction is shown in Nos. 7 and 8, Fig. 5, and in the perspective sketch, Fig. 8. The tail skid is supported on one and sprung from the other of these two bulkheads, as illustrated in Fig. 9, the general and detail construction of it being evident from the sketches. The tail plane is provided with hollow spars, which fit over cantilever beams integral with bulkheads, Nos. 7 and 8, Fig. 5, the details of which arrangement will be dealt with later.

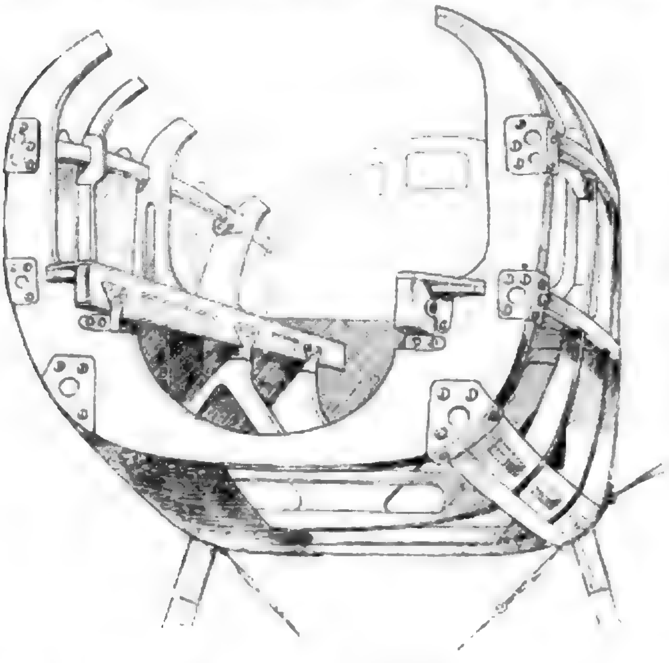


Fig. 7. Forward Portion of the Body Showing Engine Bearers

The Body Longerons

The body longerons are of a somewhat complicated nature, varying as they do along their entire length, not only as regards being tapered from front to rear, but also in the different form of spindling out employed at the various points, and in the method of reinforcing with other strips of wood, partly in order to increase their strength where required and partly to make their overall section conform to the various angles and curvatures of the outside three-ply covering of the body.

From Fig. 10 a fairly good idea may be formed of the shape and dimensions of the longerons at various points. The lower one (left hand) is originally of rectangular section, but is lightened from point to point by various forms of spindling and stop-chamfering. Thus at the point B (see key, diagram Fig. 10) the inner face of the bottom longeron is spindled out on its inner face with a curved cutter. At other points of this longeron, farther toward the stern, various sections are met with, as channel, solid rectangle, and L sections of various proportions. Between the horizontal stern post and the point at which the middle longeron meets the lower one, the latter is reinforced with a triangular section strip, so as to carry the three-ply covering into the sloping side. Similarly at the section A, Fig. 10, the longeron, which is here of solid rectangular section, is reinforced on the outer side with a curved strip, spindled out externally, and with a smaller strip on the lower face of the longeron, which at this point is subject to an increased compressive load, owing to the overhung engine. It also serves to afford attachment for the three-ply covering, which at this point changes from flat-sided to rounded section, where the sides gradually merge into the truncated cone of aluminum, which forms the extreme nose of the body proper, i. e., at the point just behind the "spinner" on the air screw boss.

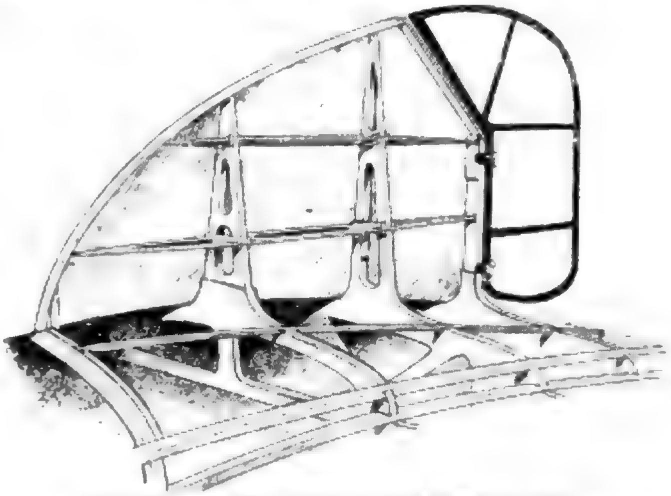


Fig. 8. Construction of the Vertical Fin

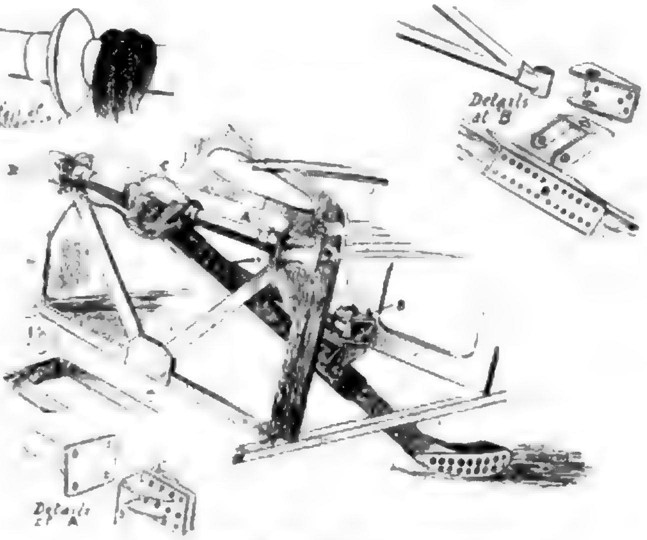


Fig. 9. The Tail Skid Attachment

The upper longeron, which is originally of rectangular section, is spindled out to channel and L sections at various points, as shown in X, Y, Z, Fig. 10. So as to form an attachment for the curved top of the body, the top longerons have glued to their upper face additional strips of triangular section, while at the point Y, Fig. 10, the section is left rectangular, so as to form a support for the gun ring. In addition to their function as strengthening members, these strips serve the further purpose of preventing the bulkheads from sliding along the longerons, as they are cut off where a bulkhead occurs, against the front and rear sides of which they abut. In some places, as, for instance, in the front of the body, where the covering is in form of an aluminum cowl over the engine, the strips are omitted and the cowl attached to turn-buttons, as shown in Fig. 12. At such points the bulkheads are prevented from sliding along the longerons by a long wood screw passing horizontally through the longeron into the bulkhead.

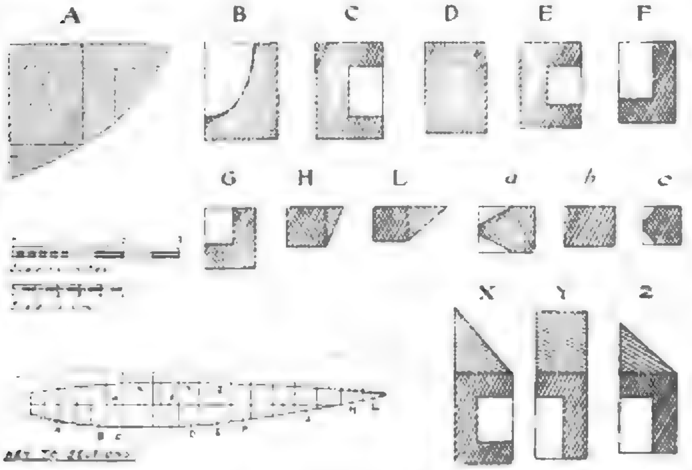


Fig. 10. Sections and Dimensions of the Body Longerons

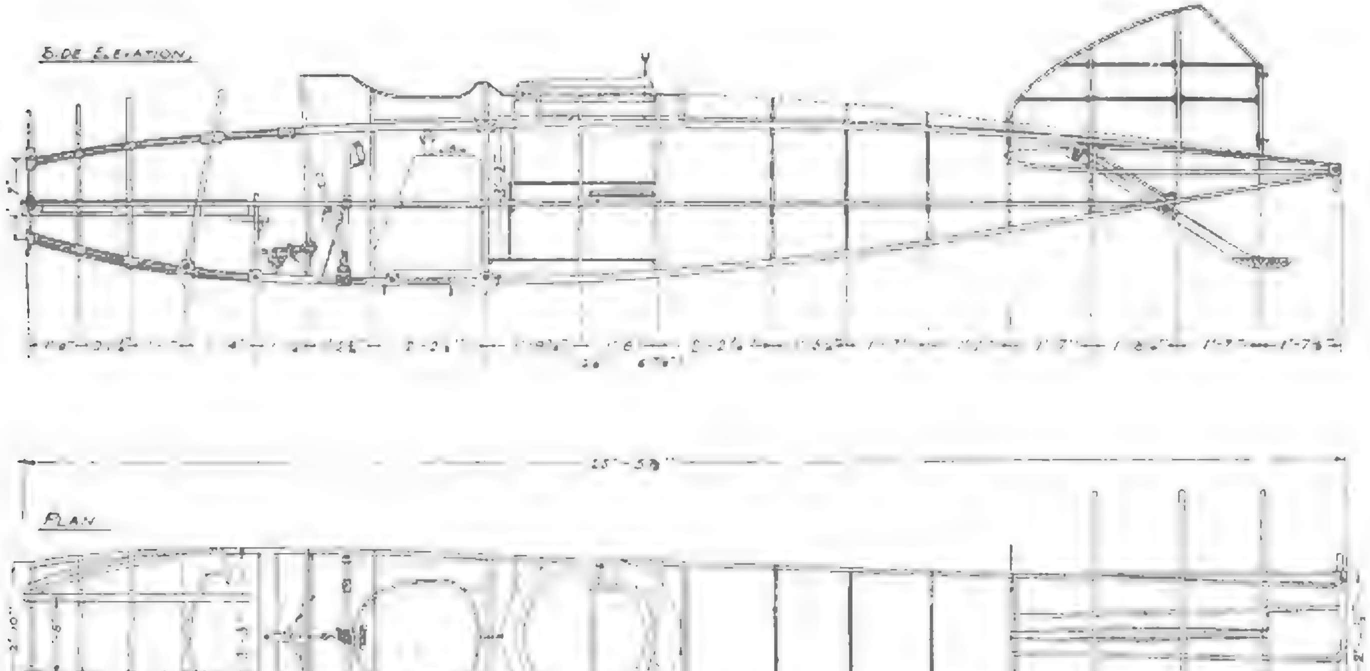


Fig. 11. Side Elevation and Plan of the Body

The middle longerons, which, as already pointed out previously, are horizontal, i. e., parallel to the propeller shaft, are of smaller overall dimensions than are the four main longerons. They are of rectangular section, lightened in places by stop-chamfering, as shown in *a* and *b*, Fig. 10.

Fig. 11 shows, in side elevation and plan, the general arrangement of the body, and should, in conjunction with the various sections and key diagrams, explain fairly clearly the general lay-out of the body. It will be noticed that in plan the sides of the body are straight from the tail post forward to the pilot's cockpit. For ease in manufacture, it is an advantage that the ribs of the tail plane should be at right angles to the spars, and in order to effect this it is necessary that the sides of the body should be parallel for the length of the tail plane. Since, however, to provide for this the longerons would have to be changed from a converging direction to a parallel one, which would necessitate a somewhat sharp bend in them at the point where the tail plane commences, and, as moreover, the depth of the tail plane is not the same as that of the body, except at the extreme rear, a different course has been followed. From the point where the tail begins, two extra longerons on each side have been built into the bulkheads of the body. These two short longerons have, in plan, a direction parallel to the line of flight, while the main longerons continue on their converging course. This arrangement is indicated in the plan view, Fig. 11. In side elevation, the short longerons, against which lie the inner ribs of the tail plane, have the same curvature as the tail plane. In this manner the lines of the rear part of the body are not spoiled, while an easy-flowing curve is provided for running the tail plane into the body.

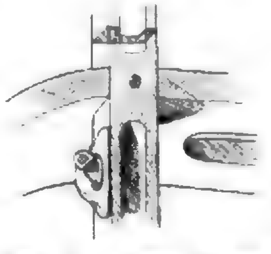


Fig. 12. One of the Turn-Buttons Securing the Engine Cowl to Upper Longerons

(To be continued)

Aeronautical Patents

ISSUED FEB. 19, 1918.

1,256,670. To William R. Fearn, Camden, N. J. Direct lifting hydroaeroplane.
1,256,812. To Joseph Mader, Minneapolis, Minn., assignor of one-third to Merritt Brandon, Minneapolis, Minn. Airplane.
1,256,823. To Cornelius H. O'Rourke, Handford, Cal. Airplane.
1,256,878. To Glenn H. Curtiss, Hammondsport, N. Y., assignor to The Curtiss Motor Co. Hydroaeroplane boat.
1,257,049. To Petro Tataryn, Chester, Pa. Winged parachute.
1,257,124. To Alfred L. Romero, Oakland, Cal. Airplane.
1,257,212. To Vincent P. Gallo, Fremensburg, Pa. Flying machine.

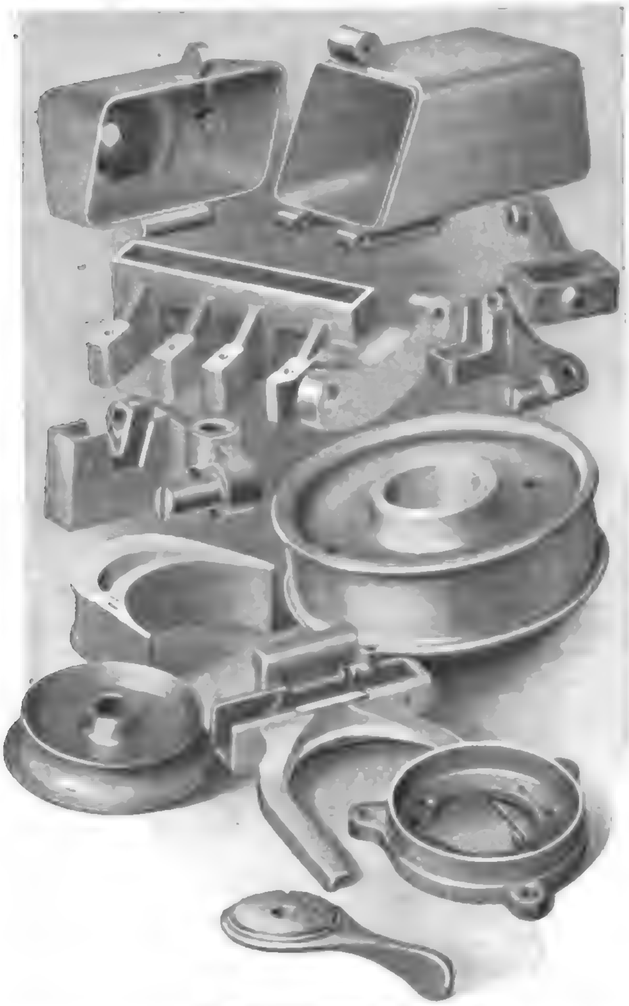
The Application of Die-Castings in Aircraft

By Charles Pack

Chief Chemist and Metallurgist, Doehler Die Casting Company

Die-Castings may be defined as metal castings made by forcing molten metal under pressure into a metallic or permanent mould. It can be seen from this definition that there are three vital factors essential to the success of a die-casting process, viz:—

1. A metallic mould or die made of a material capable of withstanding the action of the molten metal and rapid temperature changes to which it is of necessity subjected during the casting operation.



Aluminum Die Castings

2. A machine or appliance suitable for delivering the molten metal into the die or mould under pressure sufficient to insure a casting of perfect contour.

3. An alloy suitable for the process.

Die-castings being made in rigid moulds are cast close to given dimensions. A certain slight variation must, however, be allowed for, which will vary with the nature and physical properties of the alloy employed. For example, a tin-alloy die-casting can be produced and held within closer limitations than an aluminum alloy die-casting of similar shape and size. This, to a large extent, is due to the higher melting point and solidification shrinkage of the latter.

From the foregoing it can be readily seen that the main function of a die-casting is to save on the machining cost of a given part. Where this is not desired or is not of importance, the die-casting process is generally of little or no advantage.

The dies or moulds used in the die-casting process are machined from steel and to insure a die that will not crack or break up in service, the use of high grade special alloy steels are absolutely essential. The making of these dies required skilled mechanics of the finest type. The total cost of a die may vary from $150, for simple parts, to $1200 for some of the larger and more complicated parts, some dies requiring three or four months continuous labor on the part of a highly skilled mechanic, for completion. It follows from this, that the die-casting process is only applicable where large quantities of castings are required. The minimum quantity depends largely upon the amount of machining that can be saved on the particular part in question. The writer has found in his experience that few parts could be considered practical die-casting propositions in less than 1000 lots. Where 10,000 or more castings are required the die cost is readily absorbed and fades into insignificance.

With the foregoing in view, the possible applications of the die-casting process to aircraft production can be more clearly understood. Prior to the outbreak of the Great War, very few airplanes were produced in any considerable quantity in this country. Die-casting being essentially a quantity production process, it is not surprising that the use of this process should have been very limited in the airplane industry, if indeed we had any such industry at that time. The beginning of the present war also marks the advent of the commercial aluminum die-casting. Prior to that time, all die-castings produced were made from either zinc, tin or lead base alloys. Zinc alloys, although comparatively strong, are subject to corrosion under atmospheric conditions, and their use in airplane construction would be a serious mistake. Tin alloys, although non-corrosive, have comparatively low tensile strength, and their use in airplanes were limited to motor bearings. This subject is discussed more fully later. The high specific gravity and low tensile strength of lead alloys make their use in airplane construction almost prohibitive. Thus, we see at the present time with the airplane construction brought to a large quantity production and aluminum alloy die-casting developed to a high degree of efficiency, a new field of activity. There is absolutely no doubt that the die-casting will be as big a factor in aircraft production as it has been, and is at the present time, in the other automotive industries.

Heretofore, the use of die-castings in airplanes was limited to motor bearings and accessories. By accessories are meant magnetos, carburetors, speed indicators, weather gauges, starting equipment, etc., since all airplane manufacturers purchased these from standard producers of these articles. With the exception of the engine bearings, very few other parts in the airplane motor were die-cast since the quantities required were so small that it was found more economical to use other methods of production. At the present time, however, dies for some 30 airplane parts are in the process of construction or have been completed and many more are under consideration.

Aero-engine Bearings

The bearings used in an aero-engine must not be considered of secondary importance. The type of bearing used, the design of the bearing and the bearing alloy are matters that are well worth careful consideration if an efficient engine is to be produced.

The average engineer when thinking of bearing metal immediately says Babbitt. Babbitt metal is named after the inventor Isaac Babbitt, and today covers a multitude of sins. Babbitt originally patented an alloy of copper, antimony and tin with the latter element in preponderance. At the present time there are babbitt metals containing no antimony, some containing more or less lead and proportions are varied to suit the particular manipulator.

Although, the hardness of babbitt metal can be varied to some extent the fact remains that any increase in hardness is invariably accompanied by decrease in elongation or what is more commonly understood as brittleness. A soft babbitt is more likely to "squeeze" or pound out under pressure, due to its low compressive strength, whereas a hard babbitt is likely to crack or crumble under a pound. This is most particularly true of connecting rod bearings. To overcome this difficulty the so-called babbitt lined bronze back bearing has been developed and is used almost entirely in aero-engine construction.

The object of the bronze back bearing is to allow of the use of a thin liner of babbitt and combine the bearing qualities of a good babbitt metal with the compressive strength and rigidity of a good bronze. The design of the bronze back bearing, and the method of making it are of vital importance. The composition of the bronze, in the writer's opinion, is of minor importance, but the composition of the babbitt and the bonding alloy is very important.

For the bronze back many alloys have been used, and some that have come to the writer's attention are given below:—

	Copper.	Zinc.	Tin.	Lead.	Phosphorus.
1.	85	5	5	5	..
2.	88	2	8	2	..
3.	89	..	10	..	1
4.	80	..	10	10	..
5.	78	..	7	15	..

Number 1 is the S. A. E. bronze specification. The writer has had the best all round results with No. 2 alloy, but as far as the actual efficiency of the bearing is concerned, either of the alloys given above will answer just as well.

The method of joining the babbitt to the bronze shell is also important. Engineers have long recognized the fact that the mere dove-tailing of the babbitt into the bronze by means of undercuts in the bronze was not a dependable means of holding the babbitt securely in place. The modern bronze back bearing is held in the bronze by means of a perfect soldered joint over the entire bearing area. Some engineers insist on having both the mechanical and soldered bond. This in the writer's opinion is poor practice and only results in an extravagant waste of time, which at the present time should be avoided.

When the babbitt liner is properly soldered to the bronze shell, the babbitt is securely held at every point along the entire bearing area. The babbitt will continue to be so held until the bearing reaches the temperature at which the solder melts. With the proper solder this temperature is 360 deg. F., which is higher than the running temperature of any motor at this point. Since the babbitt is held at every point by the solder, there is absolutely no strain put on the mechanical joint until the solder melts. If that condition should arise in an engine any mechanical lock formed by dove-tailing the babbitt would be practically useless, since the strength of the babbitt is very low, particularly at that temperature and the transverse strain applied to the mechanical bond (or babbitt bolt) caused by rotating of the shaft, would tend to shear the bond in short order.

The foregoing is in strict accord with actual practice since bronze back bearings are now being used in a certain type of 210 hp. aero-engines where the only bond used is a good solder joint. In these engines there has been absolutely no trouble with the babbitt letting go. Mechanical bonds have, as well as in automobile engines, proved an absolute failure.

In joining the babbitt to the bronze it is important that the proper method be used. The mere application of a soldering flux and solder to the bronze shell may result in the production of a bearing that, to all appearances, is perfect. It will be found, however, that the strength of such a bond is exceedingly low. The bronze shell should be carefully cleaned and surface scale removed. The surface oxide should then be dissolved by the proper acids. The temperature and composition of solder bath should be guarded carefully.

The writer has been asked on a number of occasions to advise on the means of determining whether a finished bearing has been soldered properly. The writer frankly admits that the only proper and reliable test that he has been able to find is to break the bearing to pieces and see if it is possible to peel the babbitt from the bronze. A test generally used is the "ringing" test. A properly soldered bronze back bearing should, when held lightly in one hand and struck with a metallic rod, emit a clear ringing sound. Unfortunately this test is not absolutely convincing since the rule does not work conversely. A bearing that does not ring clear undoubtedly is not soldered properly, and should be condemned, but on the other hand when a bearing does ring, it does not prove conclusively that the solder joint is perfect since the bearing will ring true even if only the outer edges are soldered. The only safeguard is to carefully guard the various operations and break up some of the bearings at frequent intervals.

The type of babbitt to be used deserves careful consideration. There appears to be a difference of opinion amongst engineers as to the proper hardness of a babbitt liner. The writer has found, by close observation, experiment and cooperation with army aviators, that a thin liner of comparatively soft babbitt makes the best bearing. Serious difficulties have resulted from the use of hard babbitt liners, due to cracking and crumbling of the liner under continuous pound caused by imperfect fitting of the bearing. The following formulas are most generally used for babbitt liners in airplane bearings, and are given in order of the writer's preference based on actual results that have come to his attention.

BABBITT LINED BRONZE BEARINGS

	Tin.	Copper.	Antimony.	Nickel.
1.	[illegible]	[illegible]	[illegible]	..
2.	[illegible]	[illegible]	[illegible]	..
3.	[illegible]	[illegible]	[illegible]	1
4.	[illegible]	[illegible]	[illegible]	..
5.	[illegible]	[illegible]	..	..

Flax for Airplanes

The closing of the Russian ports and the growing demand for flax for aircraft fabric has prompted the British Government to create a Flax Production Department on the Board of Agriculture. The intention is, says *Flight*, to make efforts to get 10,000 acres of the crop sown in the coming Spring so as to insure an adequate supply for the year and to provide seed for next year's requirements. Flax-growing was at one time extensively practiced in England, but with the general decay of agriculture which followed on the growth of industrialism, it became comparatively a defunct industry. Yorkshire, Lincolnshire, Somerset and Fife were the chief centers, and it is in these counties that flax-growing is to be principally revived. In the Yeovil district of Somerset and at Selby flax-growing is still practiced to some extent, and in these places the British Flax and Hemp Society and the University of Leeds have done much to encourage it.

The terms that are being offered to farmers in suitable districts seem to be such as ought to induce them to carry out the board's desire without difficulty. The Government is to pay £8 10s. per ton for the total crop of seed and straw, and as a fair yield is from two to three tons per acre, and the seed for sowing is to be supplied free, there ought to be a very fair return to the farmer. Moreover, the latter is offered an additional inducement in the shape of a guaranteed minimum payment of £14 per acre for all land suitably managed, irrespective of the return of flax. It has also been arranged that in case labor trouble should be a deterrent, the Flax Production Department will weed and harvest the flax at a level cost to the grower of £4 5s. per acre.

The Bristol-Curtiss Scout Has Trial Flight

The Bristol-Curtiss fighting scout biplane had a trial flight on March 15, at Curtiss Field, Buffalo, N. Y. According to press reports quantity production will be under way before the end of the present month.

Efficiency Variation in Airscrews

By M. A. S. Riach, A.F.Ae.S., Assoc.Inst.N.A.

Difficulty is sometimes experienced, in working out the curves of performance for airplanes, in arriving at a sufficiently correct estimate of the power available at various flight speeds.

This is mainly due to the difficulty in predicting *a priori* what changes in propulsive efficiency are to be expected over a fairly large range of flight speeds. Changes in engine revolutions, due to changes in translational velocity and density variation at various altitudes, which tend to further complicate the problem, present at the outset conditions which are difficult to calculate except in particular cases, and anyone who is seeking for formula to cover most cases met with in practice is likely to be discouraged by the seeming multiplicity of variables entering into the problem and which possess no apparent easily definable connection with each other.

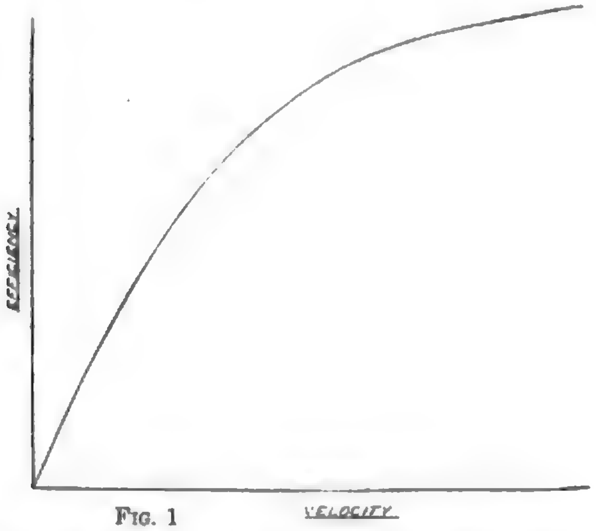


Fig. 1

In dealing therefore with those cases most likely to be of use in practical work, mathematical exactness may have to be to some extent dispensed with, providing that expressions can be obtained which shall give results correct to a sufficient degree of approximation and at the same time be of a form sufficiently simple for ordinary use.

In the first place it is as well to notice at the outset that theories, however mathematically perfect they may be, can never be more than approximations to the facts if the assumptions upon which they have been built up are only near guesses at the truth, and it is indeed well to bear this in mind to avoid unnecessary labor in obtaining expressions which, analytically exact though they may be, still remain of the order of approximations only when their initial premises are themselves but approximations. There is unfortunately a certain type of person who is never able to appreciate the value of work of this kind and, in consequence, is very apt to deride what he describes as "theory" when any set of approximate solutions do not happen to agree with experiment.

These considerations, which apply to most branches of engineering science, are equally pertinent to the problems under discussion in this article.

There are two main variables which change the efficiency of an airscrew at different velocities of translation—namely, the slip or wake velocity and the drag/lift ratios of the blade sections.

The first is a necessary change considered from the point of view of the dynamics of fluid propulsion, whilst the second is incidental to the mechanism of propulsion employed.

Neglecting for a moment this secondary cause of loss in efficiency, we can, using R. E. Froude's expression for screw efficiency, write:—

$$\eta = \frac{V}{V + \frac{S}{2}} {}^{*}$$

where V represents the transitional velocity through the fluid and S the slip or wake velocity requisite to produce an axial thrust.

Since the above formula takes no account of the drag losses already mentioned, or of the race losses discussed in a previous article,† we infer that actual efficiences met with in practice will be less than those which it gives.

This being so, let us write as a first trial:

$$\eta = \frac{k.V}{V + \frac{S}{2}} \text{ where } K < 1.$$

Then, in order to apply this expression we must know how S changes with changes in V. This will be supplied by the following expression.

The useful work done per second axially is:

$M.S.V.$, where M = Mass/sec.: of fluid through screw‡, so that the requisite B.H.P. to produce such work can be written:

$$H = \frac{M.S.V}{550.\eta} \text{ in lb., ft., sec., units.}$$

η being the propeller efficiency.

Now $M = \frac{\pi}{4} D^2 \cdot \rho \cdot \left(V + \frac{S}{2}\right)$, where D = diameter of screw in feet,

and since $$\eta = \frac{k.V}{V + \frac{S}{2}}$$

we have $$S = \frac{2.V. (k - \eta)}{\eta}$$

and $$V + \frac{S}{2} = \frac{k.V}{\eta}$$

so that: $$H = \frac{\pi.k.D^2.\rho.V^3. (k - \eta)}{1100. \eta^2}$$

or, $$\frac{1100. H}{\pi.\rho.D^2.V^3.k} = \frac{(k - \eta)}{\eta^2}$$

which gives in a simple and concise form an approximate formula connecting the air screw efficiency η with the other quantities involved, namely, H, ρ, D, and V. The value of k may be taken as varying between about 0.8 and 0.85. A value of $k = .82$ is probably a fair estimate to make. It is seen from the formula that η is a maximum when it reaches the value of k, and 82 per cent efficiency is probably a limit seldom attained in practice. A typical graph of η against V, plotted from this expression, is given in Fig. 1. This formula, while very simple and easy to apply, possesses one weak point. For values of the flight speed which are *less* than the speed for which the airscrew is designed, the results given by the formula are probably sufficiently accurate, but for values *considerably in excess* of the designed airscrew speed the efficiency of the airscrew falls very rapidly, although the formula given would make the efficiency progressively increase with increase of translational speed.

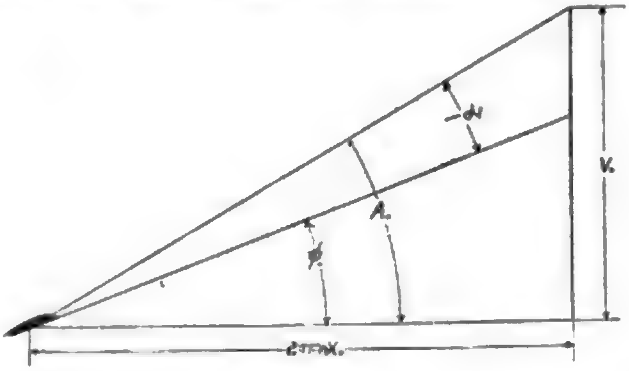


Fig. 2

This defect in the formula is important when dealing with

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[*] "The Screw Propeller in Air," by M. A. S. Riach, read before the Aeronautical Society in March, 1917.

[†] *Vide* "The Screw Propeller with Race Rotation." *Aeronautics*, September 19, 1917.

[‡] *Vide* "The Screw Propeller in Air."

propellers which have been designed for very low flight speeds, as, for instance, in order to obtain improved climbing speed.

In order, then, to take account of this fall-off in propeller efficiency, it is necessary to introduce into the formula an expression which shall more correctly measure the drag losses at translational speeds in the neighborhood of that at which there is no axial thrust. This is necessary for the reason that, *apart* from such losses, no power is required to turn the propeller when the axial thrust is zero.

Since the translational speed for zero thrust will not differ very greatly from the speed corresponding to the zero lift angles of the useful portion of the blade, we can roughly estimate the value of this speed which will then give us another point on our efficiency curve indicating about where the very rapid fall-off in efficiency is likely to occur in any case.

Let Fig. 2 represent the case of the screw advancing at some translational speed V_o and giving zero axial thrust.

The angle of attack $-\alpha$,* may then be regarded as being approximately equal to the angle of the lift of the section, say β, so that we have:—

$$\tan(\varphi_o - \beta) = \frac{V_o}{2\pi . n . X_o},$$

where X_o may be regarded as being the "equivalent thrust radius" of the propeller and equal to $\lambda . D$, say, where λ is approximately the same for different propellers. If we take $\lambda = \frac{1}{\pi}$, we get:—

$$\tan(\varphi_o - \beta) = \frac{V_o}{2 . n . D}$$

from which we can at once find the value of V_o, for which the axial thrust is zero. φ_o can be taken as the chord angle of the blade at a radius equal to λ.D, or $\frac{D}{\pi}$ feet, say.

The determination of V_o will then give another point on the curve of efficiency, and thus will to some extent indicate how the form of the curve changes at speeds greater than that for which the propeller is designed. The efficiency curve will then become modified as in Fig. 3.

The work done (per second) against the frictional forces may be very roughly expressed as: $\mu\left(V + \frac{S}{2}\right)$, so that now the expression for efficiency becomes:—

$$\eta = \frac{T . V}{T\left(V + \frac{S}{2}\right) + \mu . \left(V + \frac{S}{2}\right)}$$

$$= \frac{T . V}{(T + \mu) . \left(V + \frac{S}{2}\right)}$$

$$= \frac{V}{\left(V + \frac{S}{2}\right) . \left(1 + \frac{\mu}{T}\right)}$$

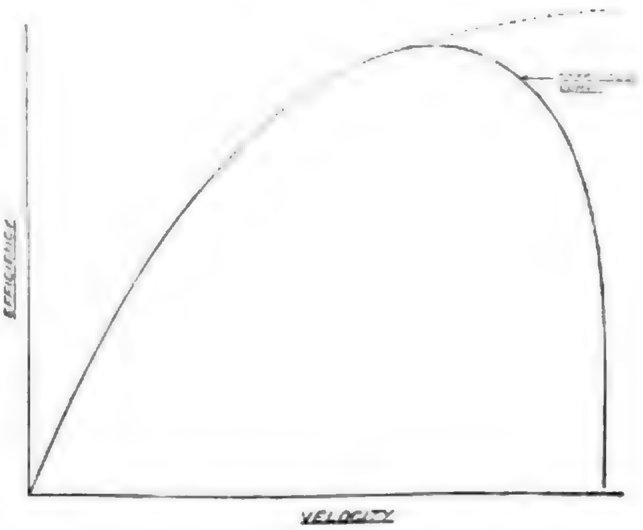

Fig. 3

$$\eta = \frac{1}{\left(V + \frac{S}{2}\right) . \left(1 + \frac{\eta}{M . S}\right)}$$

Whence it is seen that when $S = o$, $\eta = o$, since M and η may be considered as remaining constants. This shows, then, in a rough general way why the efficiency falls at zero slip due to the work required to be done in overcoming frictional losses.—*Aeronautics.*

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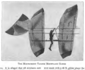
* *Vide* "The Screw Propeller in Air."

Lieut. Deullin, a New French "Ace," Aboard a Powerful Scout

(C) ***Kadel and Herbert***

An American Pioneer of Soaring Flight: John J. Montgomery

Among the pioneers of aeronautics who contributed their share in the realization of power flight there is one name which has nearly fallen into oblivion, that of Professor John J. Montgomery of Santa Clara College, Cal., whose investigations into the science of soaring flight and inherent stability deserve that his name be placed in the Annals of Aviation alongside with Lilienthal, Pilcher, Chanute and Ferber.


THE MONTGOMERY TANDEM MONOPLANE GLIDER

Attention has just been called to Montgomery's early work through an investigation made by Assistant Attorney General Huston Thompson and W. D. Eakin, who will defend the Government against the suit recently filed in the United States Court of Claims by the heirs of the late Montgomery.

Montgomery's patent, applied for in 1905 and allowed in 1906, about the time when the most important of the Wright Brothers patents were granted, claims the use of an airplane wing curved from front to rear with means for changing its curvature, and also the parabolic form of curve. It is alleged that all airplanes now used by the Government infringe his patent.

The case will probably involve the question whether the use of the small, adjustable, supplementary planes at the ends of the wings, known as ailerons, is the equivalent of the warping of the wings employed by Montgomery. A similar question formed the main issue in the litigation of the Wright Brothers against Curtiss and others.

Montgomery's first small model soaring machines were tested by dropping them from a cable "stretched between two mountain tops." These were so well designed that in whatever position dropped—head first, tail first or upside down—they righted themselves and sailed off upon an almost level course. They also responded to changes in wind direction without losing stability.

Montgomery says in describing his experiments:

"Then I constructed a large machine patterned after the first model, and with the assistance of three cowboy friends personally made a number of flights in the steep mountains near San Juan. In making these flights I simply took the airplane and made a running jump."

That his assistants were cowboys may have some connection with the fact that the pilot sat on a saddle with his feet in stirrups, by which the machine was controlled. Thus he literally "saddled the wind." Cords ran from the stirrups to the outer, rear corners of the wings, and by bending them downward controlled the course of the machine.

On one occasion a pilot pressed too hard upon one of the stirrups and his winged steed rolled over in the air, "like the turn of a cartwheel," but corrected itself with one roll and proceeded upon an even keel. This accidental but successful loop-the-loop was undoubtedly the first in the history of flight.

At the conclusion of one of his gliding flights down the mountain side Montgomery landed with one foot in a squirrel hole and so injured his leg that thereafter he was compelled to employ parachute jumpers to make descents from balloons. He states that he had sixteen applicants on his waiting list.

Professor Montgomery complains in his writings that his men were so eager to outdo each other in making spiral loops and figure eights that, "after these antics," he had to limit mechanically their control of the machine so as to permit only straight flights or long curves to prevent them from killing themselves. After being injured he planned to build a machine large enough to carry two men so that, though crippled, he could go along to direct his pilot and make observations.

In the first test from a balloon he wanted the pilot of the glider to cut loose at a small elevation as a test, but the pilot, probably with experience in parachutes that took time to open out, made it understood that he was no small pond duck but a high diver and insisted on launching from a thousand feet or more. The landing spot was prescribed, a mile away. Upon his cutting loose he lost his directions and started away from the spot, but regained his bearing, brought his craft around and, passing through two or three clouds, proceeded to the landing place. After hovering over it, he settled gently to the ground. He had flown eight miles in twenty minutes.

These soaring tests were made with a 45 ft. glider about the time that the Wrights were experimenting at Kitty Hawk, N. C.

The accounts of Montgomery's first flights, describing considerable stretches of perfectly horizontal flight, intimate that his machine employed to some extent the "internal energy of the wind," which was the subject of much of Langley's research. Similarly, by taking advantage of certain changes in direction and velocity of the wind, as the soaring birds do, the energy of their bodies moving successively as a kite string. Orville Wright, in 1911, long after the advent of the airplane, returned to Kitty Hawk, the scene of his early gliding and power flights down Kill Devil Hill, and there, without an engine, rose on a fifty-mile gale and stayed up for nearly ten minutes.

Montgomery's experiments with curved wings were much retarded by his failure to copy in all features the wings of the gull, after which his wings were patterned. At first he could see no reason for curving the forward edge downward. It has since become known that a curved wing exerts a lift even though it be tilted downward three or four degrees below the plane of the wind, making the angle of incidence negative. He finally suspected that nature was correct, however, in giving a sharp downward curve to the forward edge. He set a barn door in the position of an airplane wing in the wind and released thistle down in front of it. He found that the air changed its course before reaching the obstruction and struck it at an upward angle. Then he reproduced faithfully the wing of a soaring bird and constructed his most successful gliders.

Following the same pattern he later produced wings having approximately the same ratio of length to chord, that is, an aspect ratio of 1:1 in order to compromise between lifting power and structural strength. The longer and narrower the wing of a given area, that is, the higher its aspect ratio, the greater is its efficiency, but considerations of strength make it impracticable to extend them beyond certain limits. Therein lies the explanation of the use of biplanes and even triplanes in the great lifting machines. Montgomery's machine was a so-called tandem monoplane, the wings being placed behind, instead of below, one another.

The small relative efficiency of a wing of low aspect ratio accounts to some extent for the lack of success attained by the airplane of Maxim, who spent a hundred thousand dollars upon it a few years before power flight was mastered by the Wrights.

Montgomery's point of power application was of course identical with his center of gravity, since gravity was his power. The only other force acting upon his machine was the air resistance. Thus the only line of stress was between the center of pressure and the center of gravity, and his machine had somewhat the inherent stability of a parachute.

Professor Montgomery's experiments began in the early eighties. Like many others he first tried machines with flapping wings. The results were of course unsuccessful, because of the great energy loss and racking effect of reciprocating motion and the inconstant application of power. In the airplane, by contrast, the pressure of each part is constantly in the same approximate direction and the changes in degree of pressure are gradual. Momentum, both in the rotation of the propeller and in the forward motion of the machine, is cumulative and is conserved instead of being broken up and set against itself as must occur in any reciprocating device.

But if Montgomery's start was not based upon the most appropriate principle of physics, it was patterned after nature's example in the flapping birds. He merely copied the wrong bird. When he changed his model to the soaring species, nature's best energy conservers, he met with success.

It is interesting to note, in view of man's endeavors to provide the airplane with inherent stability, that the soaring bird has in the bone of his head a sort of compound spirit level made of three liquid-filled tubes extending in the three dimensions, which is nature's device for automatic or reflex control.

While Montgomery's machine was only a glider, its action in the air serves as a good basis for consideration of the seeming miracle that a propeller exerting a backward pressure of only four or five hundred pounds may keep in the air a machine weighing a ton. The Wright Brothers based their calculations upon the action of similar wind coasters at Kitty Hawk. Assuming that the glide is of such efficiency as to coast down a ten to one slope at twenty miles per hour, it yields to gravity only at the rate of two miles per hour. An upward air current of only two miles per hour, a very gentle ascending breeze, would suffice to keep it up. The relatively small energy represented by this imaginary upward wind is approximately the amount of energy demanded of the engine. In this connection it is interesting to note that the Wright Brothers made many flights with an engine developing only 14 hp.

The glide is compelled by the inertia of the air over which it passes to follow a certain path more or less downwardly inclined, according to the glider's efficiency. It simply coasts down a hill of air. Now, to hold a load on a hillside we know that a horse need not exert as many pounds against the collar as the weight of the load; it only exerts a component of gravity's force, determined by the slope of the hill. So with an airplane; the engine for horizontal flight needs to exert only sufficient force to hold the machine on a hillside of air.

In 1905 one of Montgomery's jumpers, Maloney, was to give an exhibition for a military company, in which were many of his friends, to whom he had promised a sensational flight. In the rise from the ground one of the balloon's guy ropes whipped around the glider's framework and broke it. A warning was shouted to Maloney, but he either did not hear it, or else preferred to take the risk rather than disappoint his friends. He proceeded to a great height and cut loose. The glider turned over and settled to the ground like a parachute. Maloneys' body was but slightly scratched, and it is thought that he died of heart failure on the way down.

Montgomery's own death occurred in 1911 in an attempt to launch the glider from greased skids, when a sudden gust of wind dashed him to the ground.

On the Battle Front in France

A French Town Under Bombardment of German Batteries as Seen from Aloft
Photo Western Newspaper Union

International Aircraft Standards

(Continued from previous issues)

3N17 Specifications for Aluminum Alloy Tubing

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. The specific gravity of the aluminum alloy of this specification shall not be greater than 2.85.

Manufacture.—3. No scrap shall be used in the manufacture of this tubing other than that produced in the manufacturer's own plants and which is of the same composition as the material specified.

Workmanship and Finish.—4. The tubing shall be straight, clean, smooth, and free from all injurious defects both inside and outside.

Physical Properties.—5. *Tensile Test.*—(*a*)

	Minimum tensile strength.		Minimum yield point.		
	Pounds per square inch.	Kilograms per square millimeter.	Pounds per square inch.	Kilograms per square millimeter.	Elongation in 2 inches, per cent.
Temper 1	55,000	38.6	35,000	24.6	12
Temper 2	50,000	35.1	25,000	17.6	20

Bend Test.—(*b*) A section of the tubing of a length approximately equal to the outside diameter of the finished tube shall withstand being flattened into an oval of which the minor interior axis shall be not less than 4 for temper 2, and 6 times for temper 1, the thickness of the wall of the original tube.

Hydrostatic Pressure Test.—(*c*) Each tube shall be subjected to a hydrostatic pressure which will develop a tensile stress of 7,000 pounds per square inch (4.92 kg./mm.²) in the tube, but in no case shall a test pressure of more than 1,000 pounds per square inch (0.703 kg./mm.²) be required. Each tube must withstand this test without cracks, flaws, leaks, or other defects, such as bulging.[a]

Selection of Test Specimens.—6. Each bar shall be subjected to a hydrostatic test. A tensile and a bend test specimen shall be taken from each 100 feet of tubing or lot of less than 100 feet.

Dimensions and Tolerances. 7. (*a*) The following tolerances shall be allowed on aluminum alloy tubing.

Outside diameter. (*b*) For tubes less than 2 inches in outside diameter, ±0.003 inch; for tubes from 2 to 3 inches in diameter, ±0.005 inch.

Wall Thickness.—(*c*) The wall thickness of the tube shall be not less than the specified gauge and shall not be exceeded by more than 0.004 inch for tubes less than 0.008 inch in wall thickness, nor by more than 5 per cent for thicker tubes.

Variation.—(*d*) The variation in thickness, due to eccentricity of the bore may not exceed 10 per cent of the specified wall thickness.

Length.—(*e*) When tubing is ordered in definite lengths, no length furnished shall be less than that specified.

[a] The pressure to be applied shall be calculated from the formula

$$P = \frac{7{,}000T}{R}$$

Where P = the hydrostatic pressure in pounds per square inch.
T = the thickness of the tube wall in inches.
R = the internal radius of the tube.

3N19 Specifications for Bronze Castings for Bearings

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Use.—2. These castings shall be used for small unlined bearings and bushings.

Material.—3. The castings shall have the following chemical composition:

Tin	10 to 11.5
Zinc	2 to 3
Iron, not more than	0.2
Lead, not more than	0.2
Copper	Remainder.

Manufacture.—4. (*a*) The bronze shall be made from lake or electrolytic copper conforming to I. A. S. B. specification 2N2 and pig tin having a purity of at least 99 per cent.

(*b*) No scrap shall be used in the manufacture of these castings other than that produced in the manufacturer's own plants and which is of the same composition as the material specified.

Workmanship and Finish.—5. Castings must be homogeneous and free from shrinkage cracks, spongy spots, blowholes, and foreign matter. Any castings developing defects in machining must be replaced by the manufacturer. The full weight of material in the original casting must be returned by the purchaser for each replacement.

Physical Properties and Tests.—6. Bronze castings for bearings shall have the following physical properties:

	Pounds per square inch.	Kilograms per square millimeter.
Minimum tensile strength	35,000	24.6
Minimum yield point	19,000	13.3
Minimum elongation in 2 inches	9 per cent.	

Selection of Test Specimens.—7. (*a*) The test bars shall be cast to size either from the casting, if the size of the same will permit, or from a separate block. The test bar shall be connected with the casting or block by a 0.125-inch (3.18 mm.) gauge running the entire length of the test bar.

(*b*) The test bar shall be of such a form that it can be machined to the I. A. S. B. standard test bar. Its total length shall be not less than 6 inches (152 mm.) The diameter of the reduced section shall be approximately 0.57 inch over a length of 2.25 inches.

(*c*) At least two test bars shall be cast from each heat. Test bars and castings shall have the heat number cast or stamped upon them.

(*d*) One test shall be made to represent each heat, but in case of a flaw in the test bar or a break outside of the middle third of the gauge length, further tests may be made on extra test pieces, as provided for in the foregoing paragraph.

Dimensions and Tolerances.—8. All castings must be true to pattern; cores must be correctly placed. Surfaces which are to be machined shall admit of finishing to the required dimensions without leaving any trace of the original surface.

3N22—Specifications for Free Cutting or Screw Machine Brass Bars

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Use.—2. This material is to be used for screw machine work; it is not suitable for structural parts of airplanes and is intended only for use in machine parts not subject to considerable stress.

Material.—3. The bars shall have the following chemical composition:

	Per cent.
Copper	60.0 to 63.0
Lead	2.25 to 3.25
Iron, not more than	.10
Other impurities, not more than	.25
Zinc	Remainder.

Manufacture.—4. The brass shall be made from lake or electrolytic copper conforming to I. A. S. B. specification 2N2 and spelter of "C" or "D" grade conforming to I. A. S. B. specification 2N3. No scrap shall be used in the manufacture of these bars other than that produced in the manufacturer's own plants and which is of the same composition as the material specified.

Workmanship and Finish.—5. All bars shall be sound, straight, free from rooks, laps, cracks, twists, seams, and damaged ends, and are to have a workmanlike finish.

Physical Properties and Tests.—6. The bars shall have the following physical properties:

Tensile Test.—(*a*)

	Minimum tensile strength	
	Pounds per square inch.	Kilograms per square millimeter.
Bars less than 1 inch in diameter	55,000	38.6
Bars from 1 to 2 inches in diameter	50,000	35.1
Bars over 2 inches in diameter	45,000	31.6

Bend Test.—(*b*) The bars shall withstand being bent cold through an angle of 120 degrees to a radius equal to the diameter of the rod without cracking. The bend test bar shall be full size up to a diameter of 1.50 inches. Test bars of rods of larger diameter may be machined to a diameter of not less than 1 inch.

Selection of Test Specimens.—7. The bars shall be grouped into lots of not more than 500 pounds if of one-half inch or less in diameter, or into lots of 50 pieces if larger. A tensile-test specimen and a bend-test specimen shall be cut from one bar of each lot.

Dimensions and Tolerances.—8. Bars shall not vary in diameter more than the following amounts:

	Inch.
For bars up to and including 0.375 inch in diameter	± 0.0015
For bars from 0.375 inch up to and including 1 inch in diameter	± .0030
For bars over 1 inch in diameter	± .0050

Delivery, Packing, and Shipping.—9. (*a*) Bars when ordered to any length shall be furnished in stock lengths unless specifically required that lengths be exact.

(*b*) Stock lengths will be as follows:

When ordered in 12-foot lengths, no length shall be less tan 8 feet.
When ordered in 10-foot lengths, no length shall be less than 6 feet.
When ordered in 8-foot lengths, no length shall be less than 6 feet.
When ordered in 6-foot lengths, no length shall be less than 4 feet.

(*c*) When ordered to the lengths given above, the weight of lengths less than length ordered shall not exceed 40 per cent of any one shipment.

Digest of the Foreign Aeronautical Press

The Aeroplane (London), February 20, 1918

Commercial Aviation Possibilities in China—By Allen J. Daniels.—China to a great number of people conveys the idea of a large cultivated country, peopled by millions of half-savages. As a matter of fact, the country in reality is as different as possibly can be from such a state. The land is cultivated on every inch of fertile soil, the people are solid, industrious and far ahead of a great number of so-called civilized countries.

One of the greatest drawbacks to China's progress at the present time is the lack of means of communication. By far the greater portion of China's internal commercial traffic is carried on by water. Railways are only in their infancy: they are slow and very unreliable. On the so-called long-distance journeys there is usually only one train up and down per day, and it takes one, on an average, three times as long to accomplish a distance as it would on a European line.

It is really only quite recently that a postal system has been inaugurated, but the people have been very quick in learning its uses, and have taken up its advantages with enthusiasm, as will be seen from the fact that the receipts for the last financial year exceeded the expenditure by nearly two million dollars. The Chinese have taken very kindly to the "Express" post, and a great amount of mail is carried "Express" now, and the volume is increasing daily.

It is safe to say that the Chinese would welcome any means that would accelerate the mails to the utmost. Of course, as the railways increase in number and efficiency, the mails will be greatly accelerated, but should a system of mail-carrying by air be introduced, it would take but a very little time to make it a good paying enterprise.

For the purpose of mail-carrying, the waterplane would be a far more useful machine than the land plane, at least for the next few years, as there are very few places of importance that are not close to some waterway. And it is safe to say that a good-sized waterplane would find little difficulty in rising from or landing on any of the rivers of this country.

With regard to the fuel supplies, this would present no difficulties whatever, as there are already two large oil companies in China with a network of agencies and sub-agencies over most of the country. These companies are spreading rapidly, and, in a very short while, will embrace the whole of China.

The Chinese themselves could easily be trained as mechanics, and, if necessary, as pilots. They have proved themselves to be very apt motor-car drivers with little or no nerve. There are hundreds of motors and steamboats in China run by Chinese engineers entirely, and I feel confident that with special training the Chinese would become expert airplane mechanics.

China is taking an interest in aviation from a military point of view, and there are one or two machines and pilots capable of flying, as will be seen from the fact that the Military Governor of the Province of Hunan, who is at the time of writing trying to quell a rebellion in his Province, has asked the Central Government to help him by sending a couple of airplanes.

Aeronautics (London), Feb. 27, 1918

The Air Force Estimates.—On Feb. 21, for the first time in English history, the House of Commons considered the Air Force Estimates, which were introduced by Major Baird, Under-Secretary of State to the Air Ministry. Major Baird outlined the composition of the Air Council and the respective functions of its members as follows:

The chief of the Air Staff is charged with advising His Majesty's Government as to the conduct of air operations in all questions of air policy affecting the security of the Empire, including home defence. He is further charged with liaison with the Allies, with the Admiralty, and with the Army Council as regards policy, operations, and intelligence. Under his department falls the subject of policy as to air organizations and establishments. The principles of training are laid down by him. Schemes of development of the air force are also settled by him. Guidance as to the specifications of aircraft, engines, armament, ammunition, and other equipment, strategic and tactical dispositions of air stations, and general schemes for works and aerodromes—that covers, briefly, the sphere assigned to the Chief of the Air Staff.

The Master General of Personnel corresponds generally to the Adjutant General on the Army Council. He is charged with the duties of raising the personnel of the air force, with its maintenance, both in officers and men, with the selection of candidates for commissions and with the posting of officers and men to the units to which they belong.

Discipline and all legal questions connected therewith fall within his sphere, as well as the arrangements for the medical and sanitary services.

The Controller-General of Equipment combines the functions of the Master-General of the Ordnance and the Quartermaster-General on the Army Council. He is charged with the supervision of the provision of aircraft, engines, armament, ammunition, and other equipment in accordance with the schemes and guidance as to the specifications of the department of the Chief of the Air Staff, and the arrangements with the Director-General of Aircraft Production for the production of these stores, and for experiment and research to improve the designs and supply of all such equipment.

The Director of Lands is charged with taking over, whether by agreement or under the Defence of the Realm powers, all land required by the Ministry, and the management and maintenance from an estate point of view, and subject to the requirements of the air service, of all lands taken over, exclusive of any constructional work. All constructional work falls within the province of the Administrator of Works and Buildings. I may say that we have taken over *en bloc* the works and lands held by the Army Council and the Admiralty respectively in connection with the Royal Flying Corps and the Royal Naval Air Service.

The duties of the Parliamentary Under-Secretary of the State combine, *mutatis mutandis*, the functions of the Parliamentary Under-Secretary of State for War and the Financial Secretary to the War Office.

The duties of the Secretary to the Air Council comprise the general control and cooperation of Air Ministry procedure and of the conduct of official business in the Air Ministry.

Aeronautics (London), March 6, 1918

Standardization of Aero-Engines—An interesting sidelight was shed on the British aero-engine situation in a speech made by Mr. Pemberton Billings on Feb. 27 in the House of Commons. Mr. Billings said: At the present time we are carrying spare parts to the extent in London alone, I think, of something like £15,000,000 value for airplane engines. I have heard of a sum almost equalling that I do not say being wasted but lying dormant in other parts of the country, so that spare parts may be ready for all these engines to which I propose to refer.

I may say that our enemies, the Germans, have succeeded in reducing their standard engines to approximately 7 per cent. They employ 160-hp. 6-cylinder Mercédès and 260-hp. 6-cylinder and 240-hp. 8-clinder Mercédès; 130-hp. 6-cylinder and 240-hp. Benz; 250-hp. 8-cylinder Maybach; 100-120-hp. 9-cylinder rotary Monosoupape Oberursel, and 160-hp. Austro-Daimler. With one or two exceptions, this is practically the whole output of enemy airplane engines. Seeing that our enemy has efficient engines, seeing that we who have access both to the assistance of America, Italy, and France, three of the greatest engineering countries in the world—America for production and France and Italy for high efficiency—we yet find ourselves at the end of three and a half years of war without one engine that we can really rely on.

Despite the protestations of certain honorable members, or the protestations of the representatives of the Air Ministry in this House, that I am utterly wrong as to the forty-four types which were standardized, or forty-four engines which were carrying spare parts, I find on referring to my old service notes, and to information at my disposal today, that at least sixty-one engines have been standardized, and that is anything but a complete list. I find that 90-hp., 110-hp. and 130-hp. Clerget, 100-hp. and 120-hp. Monosoupape-Gnôme, and 80-hp., 110-hp. and 130-hp. Le Rhône, three distinct types of engines, have been in the recent past standardized engines of both the Royal Flying Corps and the Royal Naval Air Service, the spare parts blocking up the stores of the Royal Flying Corps and the Royal Naval Air Service. If an engineer were asked to give a report he would tell you that there is nothing between the Clerget and the Le Rhône, either the 80-hp. or the 110-hp. or the 130-hp. So far as the Naval Air Service is concerned, they have got the 100-hp. Monosoupape-Gnôme. There is the 80-hp. ordinary Gnôme. I do not know whether it is established or whether it has been wiped out.

There is the 250-hp. Sunbeam 12-cylinder, and the 360-hp. Sunbeam 18-cylinder, and the 275-hp. 12-cylinder and 8-cylinder. Here we have four different types of engines and four different complete sets of spare parts to be attached to every squadron. We come to the Eagle Rolls Mark III. 12-cylinder, and the Falcon Rolls 12-cylinder and the 175-hp. 6-cylinder, and we come to the Green 80-hp., 160-hp., and 360-hp., all involving sets of complete spare parts. We come to the Renault-Mercédès, the Lorraine-Dietrich, and the Beardmore-Daimler 120-hp. and 160-hp., and the Smith 140-hp. We come to the Curtiss, and this country, I may almost say, is littered with Curtisses.

Now is the time for the Air Minister to adopt a firm attitude on this question. He should say that out of these sixty-three types of engines there should be one on which we can rely for training, one or two for fighters, and two, three or four for bombers, and that we will put our faith in those, and he should cancel all the contracts of all those people, who are simply wasting priceless materials and workmanship making engines that will never be employed. He should also cancel the vast orders for spare parts and concentrate on about six types of engines and devote all our energies to making those engines as perfect as possible. We come to the Hispano-Suiza 150-hp., 150-hp. geared, 200-hp., 200-hp. geared, 200-hp. *Poussé*, 200 hp. *Surcompressé*, Peugeot, Brasier, Wolseley. We come then to the Wolseley-Adder and Viper, two more types, and we have the Arrol-Johnston 120-hp. and 150-hp. and the Galloway 160-hp.—another lot of engines with none of them interchangeable in any way. We come to what has been the cause of half the tragedy of our experiments, the R. A. F. 90-hp. 8-cylinder, 100-hp. 8-cylinder, 130-hp. 12-cylinder. We have the Renault 70-hp. and 80-hp.

Then there is the A. R. 1, a very excellent engine, I believe, the result of designs in the Admiralty. There is then the B. R. 2 and the A. B. C. 45-hp. 2-cylinder and 160-hp. 7-cylinder, and the Fiat engine, standardized by the authorities, and the Salmson 90-hp., 160-hp., and 200 hp. The honorable gentleman (the Under-Secretary for Air) laughs at that, but I ask him at what date these engines were finally deleted from stock, and whether any firms, and how recently, have been engaged in making spare parts. He might also inform us of what he knows of the latest type of this kind, and whether it is not the finest engine which the Allies have at their disposal today. We also have the Anzani 60-hp. and 160-hp. and the Sturtevant 120-hp.

Flying (London), March 6, 1918

The New German Giant Airplanes.—Allied aeronautical circles have for some time been aware of the existence of a new German "giant" airplane, veiled references to which have recently appeared in the German press.

It appears that most of these machines are very big biplanes equipped with four engines. The engines are placed between the wings much in the way that the engines of the Gotha biplanes are placed, but tandem fashion, so that one engine on each side drives a pusher air-screw behind the wings as in the Gotha, and the other engine on each side is placed immediately in front of it and drives a tractor air-screw.

Less is known, at any rate outside the Intelligence Department, concerning the six-engined *Riesenflugzeug*, but it is assumed that it is probably a large triplane similar to the Caproni, probably with two bodies, with a central body between them, in which case the central body would probably carry an engine at each end—one driving a tractor screw and one a pusher—the other engines being disposed in pairs on the wings outside the twin fuselages. There are, however, several other ways in which these engines could be placed on a giant airplane, and as the six-engined type must be at present purely experimental even in Germany, it seems improbable that any particular engine arrangements have yet been standardized.

The chief reason for the existence of these giant machines is that they may carry enormous bombs which, according to German estimates, are to abolish whole sections of a city in one swoop. That is to say, instead of carrying two or three bombs of 200 lb. apiece they will probably carry two or three bombs of 1000 lb. apiece, or possibly one enormous bomb of even greater weight.

The American Aircraft Situation

American production of combat planes has been slow in gaining momentum, but during July we will be able to keep pace with the Army's actual participation in the fighting. In the meantime machines will go forward in gradually increasing numbers. Deliveries of single-seater fighters, pursuit and artillery control machines, orders for which were placed abroad, are now beginning to be made to General Pershing. The production of training planes is keeping pace with the present requirements. Within thirty days production will reach a point which will necessitate the storing of some of these machines as a reserve. These are the salient facts vouched for by one of the highest officials of the Air Service during an interview given a representative of AVIATION AND AERONAUTICAL ENGINEERING on March 25.

At a joint meeting on March 30, the War Council and the Senate Committee on Military Affairs discussed at length the military situation on the western front in France, and all phases of ordnance progress and preparation and the aircraft situation.

The exact condition in regard to the aviation program and the present state of progress was disclosed. The information laid before the Senate Committee confirms the outline of the situation given above. It was definitely shown that there is no ground whatever for statements which have been made by persons summoned before the Senate Committee that not more than thirty-seven all-American fighting machines will be delivered to General Pershing by July 1. On the contrary, unless the bottom drops out of the entire organization, and the great plants which are turning out motors and beginning to turn out planes other than those of the training type, which already are being delivered in large quantities, and have been for many weeks past, General Pershing will have by midsummer all the American planes he can use on the front.

A report said to have been made to the President by Gutzon Borglum on the aircraft situation was printed in part in the New York *World* of March 22. It must be remembered that these statements apply to the situation as it was supposed to exist early in January. Investigation indicates that the printed report is full of inaccuracies and exaggerations; that it is highly overwrought. The truth lies between exaggerations on both sides of the question. It will be found nearer the side of optimism than of pessimism. The heads of the Air Service, it is said, will welcome publication of the facts developed by the investigation being made by Snowden Marshall, E. H. Wells and Gavin McNab at the instance of the President.

The program is far from having collapsed. It is agreed that the public has been misled as to probable accomplishment by ill-informed publicity, a great deal of which, it should be noted, emanated from official sources. It is also officially admitted that mistakes of omission and commission have been made, as well as miscalculation of the difficulties to be overcome.

The original General Staff program upon which the $640,000,000 appropriation of last July was based did call for 22,000 Army machines of all types during 1918. But the incorrect impression seems to have gotten out that these were all to be "fighting" planes. Another inaccuracy pointed out is that the *revised* schedule is said to call for 11,000 combat planes by the end of November. As a matter of fact, the *original* schedule called for that number of machines of all types by the time mentioned. Revised estimate of February provides for from 2100 to 2200 combat planes by July.

One of the Borglum statements is that contracts for 7500 training planes have been let, and that after seven months we have 1444 on hand, of which 40 per cent are either worn out or useless. The official tables now show more than two and a half times this number. He also asserts that production of training machines does not exceed 11 per day. The official tables show a production of about 50 per day.

More than 200 Liberty engines will be ready for foreign shipment by the end of April, and more than 2000 by the end of July, according to revised schedules. By the end of November 11,000 are expected to be on hand. When maximum capacity is reached, a daily production of 150 engines is expected. This statement is, of course, indefinite, but it is based on far better information than was available when the first contracts were let for a practically untried engine.

Comment on the conditions which are said to exist in the airplane factories would serve no good purpose at this time. Conditions are under investigation by an unprejudiced commission of practical men, and the facts will doubtless be made public at the proper time. As to the countless changes in design which are complained of in the Borglum report and in the Providence *Journal's* investigation, the facts are about correct; but the conclusions drawn from them are not. Nor have the changes originated within the organizations of the aircraft manufacturers. They have been dictated by the constant evolution of machines at the front, and by changes in detail to adopt parts and fittings to quantity production and a desire for the utmost perfection and efficiency. The result of this policy, over-standardization and reliance on machine production, is exactly what aircraft engineers predicted at the start.

It should be recorded here that the personalities directed against Colonel Deeds and General Squier by Mr. Borglum are considered ridiculous, and are given no credence by the Secretary of War, or by any others who know these officers.

The statement has recently been made that America has never intended and does not now plan to build single-seater fighters, because of constant changes in type and our great distance from the front. In fact, the trend has drifted away from the single-seaters to the more powerful squadron fighters. The work of constructing the small fighters and pursuit machines has, therefore, been left to France and England, upon General Pershing's recommendation. How this statement is to be reconciled with the published fact that large orders were in January placed with Curtiss for the Bristol single-seater fighter is one of many mysterious conflicts in information. Reports lately indicate that the single-seater will continue to play an increasingly important part in the air fighting.

Various rumors have been current as to the performance of the American built De Haviland machine fitted with the Liberty engine. These were to the effect that the speed of this machine was as low as 90 and as high as 138 m.p.h. The representative of AVIATION was shown the tabulated performance records of all types of foreign machines, and can state that the speed the American De Haviland is officially credited with exceeds anything shown on the foreign performance tables. If these machines approximate the speed indicated under average battle conditions they will do as well as their English prototypes.

Offsetting certain charges made by Mr. Borglum, responsible officials reiterate that the Liberty engine is a success; that there has been no profiteering; that if the prices were high they were based upon speed of production, "the essence of the program"; that there was no deliberate retardation; that there were many mechanical difficulties which had to be overcome, due largely to lack of experience and the fact that they were creating an entirely new industry; that there was an overestimate of productive capacity, but that the revised schedule is still highly satisfactory from a military standpoint; that the supply and industrial conditions affected the air program as it affected every other element of our war preparation.

One point upon which all concerned on the governmental side insist is that the merit of the Liberty engine is certain and unqualified. The geared 12-cylinder model now beginning to approach quality production will develop 460 hp. on a weight of about 828 lb.; that is, a horsepower for less than 2 lb. weight.

The advanced training planes tell a different story. In this class mechanical difficulties were encountered that it has taken time to overcome, but there is reason to believe that the troubles have been corrected and that the output will be speeded up.

The recommendation by Mr. Borglum that the Government seize the chief airplane factories on the ground that $100,000,000 would be saved, morale improved, labor conditions protected, production increased 200 per cent, and the whole aeronautic department reconstructed, is unsupported by facts or figures. As a matter of fact, the Government is now in virtual control of the airplane factories through its production officers, inspectors and accountants at the plants and through credits extended by the War Credits Board.

The criticism that only a comparatively small and favored part of the country's manufacturing resources have been utilized is a familiar one. Two months ago Colonel Deeds testified before the Senate Military Affairs Committee that 65 firms and 400 sub-constractors were at work on the aircraft program. It is understood that this number has since increased. It is a fact that there has been a great deal of bitter criticism by disappointed contractors who had neither the resources nor capabilities to manufacture airplanes or parts. On the other side there have been cases of what appears to be injustice to a few of the smaller airplane concerns which might have been practically subsidized and told to go ahead and produce something. If only one successful fighting machine had resulted from a dozen failures, the justification would be sufficient.

The Borglum report includes an argument for the creation of a separate department of aeronautics to be distinct from both the Army and the Navy. Commenting on this in its news story on the Borglum report, the New York *World* says: "In this respect Mr. Borglum coincides with certain suggestions that have been made from time to time by the Aero Club of America."

The official publicity on the airplane program has in the past dealt entirely in generalities. The official statements have always been qualified by large "ifs." Promises for the future have been made instead of telling the public the present situation. The "ifs" are forgotten now. The public was led to expect wonderful performances. The inevitable reaction has come. There have been many failures and disappointments; nevertheless, genuine progress has been made. But the policy of concealment for the facts, and overwrought publicity for the promises, has resulted in one of the biggest "failures" in the present situation. It is now less a matter of violation of military secrecy than of maintaining public confidence.

It is understood that the Aircraft Board is now preparing an accurate statement of the situation which will help to restore confidence. This is needed.

New Endurance Record

A Model 5A 8-cylinder, 150 hp. engine, manufactured by the B. F. Sturtevant Co. of Hyde Park, Boston, Mass., in the L-W-F Engineering Co. training biplane No. 83, established a new American endurance record, with a passenger, on March 28, at Ellington Field, Houston, Texas. The machine remained in the air continuously for a total flight of nine hours and fifty-three minutes. The pilot was J. H. Yelle of the B. F. Sturtevant Co. The machine left the ground at 8:25 a. m. and landed at 6:18 p. m. The greater part of the flight was over the town of La Porte. The engine, according to reports, did not miss an explosion during the entire flight, and the machine was only forced to descend after every drop of gasoline had been consumed. The flight was made with 93 gal. of gasoline and 11 gal. of oil. It ended with no gasoline and 5½ gal. of oil. The condition of the engine after the flight indicated that it could have remained up for several hours longer if sufficient gasoline could have been carried.

Recruiting of Non-Fliers Stopped

The work of recruiting for the non-flying units of the Aviation Section of the Signal Corps has been stopped temporarily. Orders to that effect have been dispatched from Washington to all recruiting boards throughout the country.

It is stated the reason is that sufficient recruits have been obtained for all those units so far organized and no more applications will be received until additional units are required. This will not be until from one or two months. It has been understood for some time that the number of applicants has been large and that it is now very easy to obtain men for this branch of the service.

News of the Fortnight

The Latest Aerial Mail Plans

G. L. Conner, representing the Post Office Department in the matter of securing suitable sites for landing places for airplanes on the Washington-New York aerial mail route, has returned to Washington, D. C., after having spent four days on this mission in New York and suburbs. To a representative of Aviation and Aeronautical Engineering, Mr. Conner stated that in the party were also Postmaster Walter C. Burton of Brooklyn, two members of the Brooklyn Chamber of Commerce, and Major Holden and Captain Solomon of the Signal Corps.

In addition to the sites mentioned previously as having been investigated were sites in Belmont Park, Jamaica and other places on Long Island. The one which is considered most available now is a tract of Flatbush Gardens on Kings Highway, about twenty minutes haul by motor from the Brooklyn post office. It seems to be the present purpose to take this site, if a lease can be secured, but if not, one of two other sites which have already been looked over, may be acquired. It is thought a definite decision may be made this week.

If the site on Kings Highway is secured, the plan is to speed the mail by automobile to the Brooklyn post office, whence it will be shot by pneumatic tubes to the several post offices in New York City, but should the contracts for the pneumatic service not be renewed, and this question is now before Congress, it is admitted that this part of the plan will be somewhat disrupted.

The Department is now working toward the development of devices, which will permit the starting and landing of airplanes from and on a very much smaller field than is now required, or even from or on the roof of a post office or other large building. Very satisfactory progress in this direction is reported to have been made and should these devices prove to be successful, two results would accrue; the necessity of the pneumatic tubes, motor trucks and landing fields in connection with the aerial mail service would seem to be obviated, and the delivery of mail matter would be materially expedited.

It is pointed out that a landing field of the size now required, or about 2000 sq. ft., is one of the difficulties which stands in the way of the general employment of airplanes for postal and commercial purposes. It is also stated that the difficulty of securing proper sites at New York and Philadelphia will delay the opening of the route a month or more beyond the date last set. The original date was April 15, which was changed to April 25, but it is now thought that the opening of the service will be postponed to as late as May 15. It is intended, however, to inaugurate it as much earlier than the last named date as possible.

League Island, which was regarded as good as settled as the Philadelphia landing field, has necessarily been eliminated from further consideration on account of the work which is being done there for the Parking Commission and which will not be completed for about one year. The Philadelphia situation, therefore, must be reinvestigated and a committee of Department and Signal Corps officials is planned at this writing to go there for that purpose.

The extension of the aerial mail route to Atlanta, Ga., which was reported in the Aviation and Aeronautical Engineering as having been proposed to the Department by Congressman Thomas M. Bell of Georgia, is out of the question at the present time. Mr. Bell was so informed in a letter from Postmaster General Burleson on March 14. The Postmaster General wrote that there is no immediate prospect of an extension as the funds available will not permit it.

Flies from Mincola to Washington

Lieut. Georges Flachaire of the French Army's aviation corps, flew from Mineola, N. Y., to Washington, D. C., last week. Lieut. Flachaire made the 250 mile trip in a Spad fighting scout.

He started from Hazelhurst Field soon after the noon hour, but encountering engine trouble passed the night at Philadelphia, resuming the journey at 10 o'clock the following day. He reached the infantry parade grounds at Camp Meade at 11.15, descended and took lunch there and resuming his trip at 2 p. m., and was in Washington fifteen minutes later.

Lieut. Flachaire has seen two and one-half years' service at the front and has downed seven enemy planes.

$188,042,969 for Naval Aeronautics

Chairman Lemuel P. Padgett for the Committee on Naval Affairs, reported to the House of Representatives on March 19 the annual naval appropriation bill (H. R. 10854) for the fiscal year ending June 30, 1919.

The text of the paragraph making an appropriation for aircraft reads:

"For aviation, to be expended under the direction of the Secretary of the Navy for procuring, producing, constructing, operating, preserving, storing, and handling aircraft, establishment and maintenance of aircraft stations, including the acquisition of land by purchase, donation, or condemnation; and for experimental work in development of aviation for naval purposes, $188,042,969: Provided, That the sum to be paid out of this appropriation under the direction of the Secretary of the Navy for drafting, clerical, inspection, and messenger service for aircraft stations shall not exceed $300,000."

This sum is an increase from approximately $94,000,000, the amount originally asked for by the Department.

By the bill the enlisted personnel of the Naval Reserve Flying Corps is increased to 10,000. Included other legislation recommended is the transfer of all members of the National Naval Volunteers for aeronautical duties to the Naval Reserve Flying Corps, and that no officer of the N. R. F. C. shall exercise command except within his particular department or service.

It is also provided "that hereafter the allowances of officers, enlisted men, and student fliers of the naval service shall in no case be increased by reason of the performance of aviation duty."

A report of the committee accompanying the bill explains that "this provision does not take away the increased pay of aviators, but does take away increased allowances."

This is understood to have been a last minute change made in the bill at the request of Secretary Daniels, who after learning the decision reached by the Senate Committee on Military Affairs at the recent hearing on the pay of Army aviators, wrote the chairman of the House Committee on Naval Affairs, placing his department in line with the amended War Department bill.

Liberty Engined Seaplanes Fly

Naval seaplanes fitted with Liberty engines have recently made a number of trial flights.

The following statement regarding these tests has been issued by the Navy Department:

"A Navy flying boat, equipped with a Liberty engine, flew from the Naval Air Station, Hampton Roads, Va., to Washington yesterday (Wednesday, March 20) morning in two hours. The distance covered was about 180 miles. The motor and plane functioned as expected and the aviators report that the engine ran without a miss. Three naval aviators made the trip in the plane—Lieut. D. H. McCulloch, Ensign Slater, and Ensign G. M. Brush.

"Seaplane hangars have been erected on the Eastern Branch of the Potomac at Anacostia and similar flights will be made.

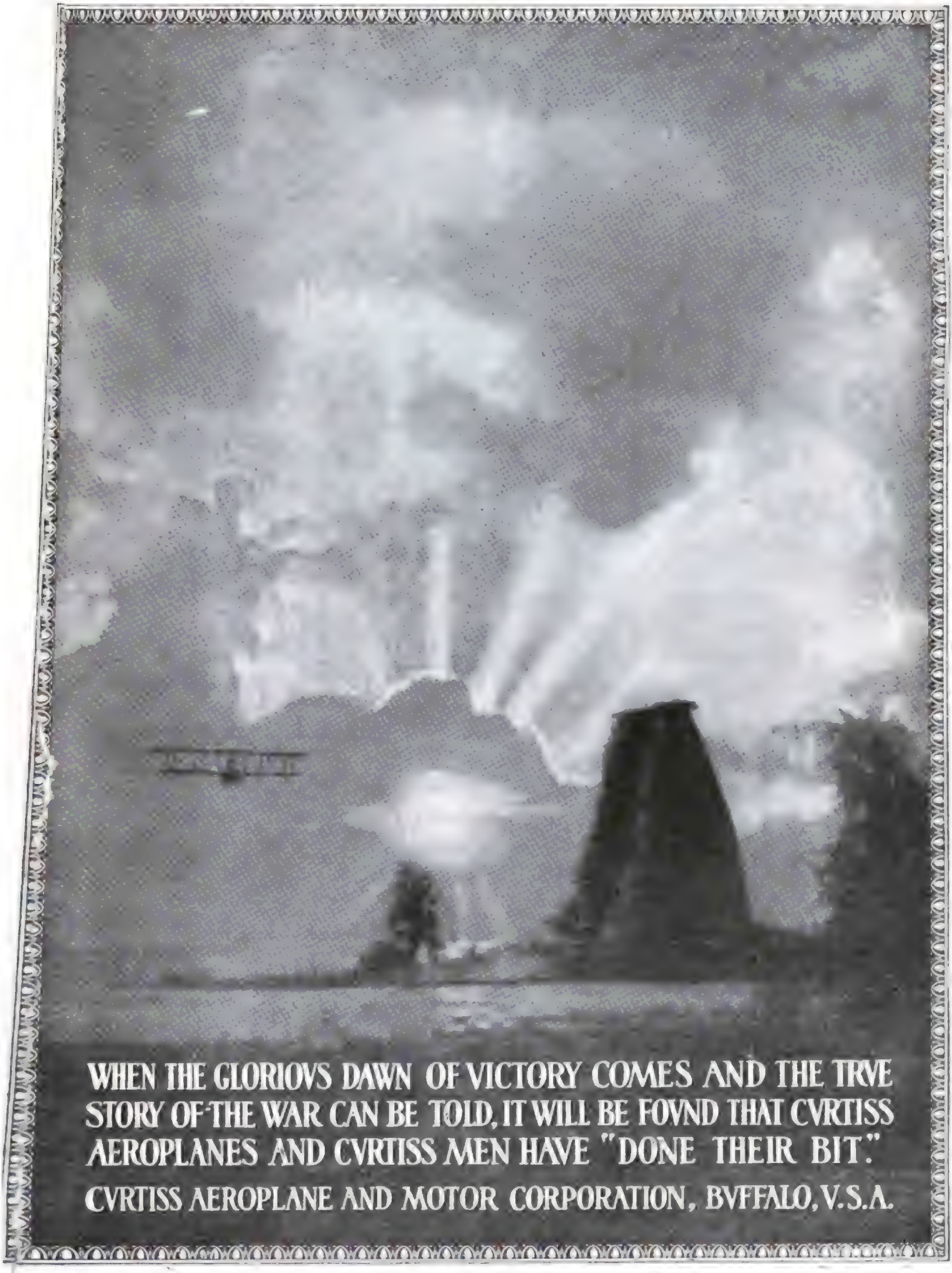
"The Navy has several service seaplanes equipped with the Liberty engine which are flying daily."

A second test on March 22 was made with two seaplanes, one of which was equipped with a Liberty engine and the other not. It was in the nature of a comparative test, with the Liberty plane winning the honors. It is stated that the Liberty outdistanced the other plane in the competition.

This test was witnessed by Secretary Daniels; Rear Admiral David W. Taylor, Chief Constructor and Chief of the Bureau of Construction and Repair; Rear Admiral Robert S. Griffin, Engineer in Chief and Chief of the Bureau of Steam Engineering, and Rear Admiral Ralph Earle, Chief of the Bureau of Ordnance.

Test of Briggs Seaplane

The Briggs Aeroplane Co., which is located in the building of the so-called Portland Brewery on Washington Street, Alexandria, Va., completed its first machine last week. This is a seaplane and is now stored in the company's hangar at Jones Point, that town. Trial flights will be made shortly. They will be in charge of Leonard Bonney.



WHEN THE GLORIOVS DAWN OF VICTORY COMES AND THE TRVE STORY OF THE WAR CAN BE TOLD, IT WILL BE FOVND THAT CVRTISS AEROPLANES AND CVRTISS MEN HAVE "DONE THEIR BIT."

CVRTISS AEROPLANE AND MOTOR CORPORATION, BVFFALO, V.S.A.

Congress Has Before It These Appropriations for Aeronautics

To continue Army program for balance of fiscal year ending June 30, 1918	$250,000,000
New Army appropriation for fiscal year beginning July 1, 1918	1,126,654,260
Naval appropriation for fiscal year beginning July 1, 1918	188,000,000
Post Office Service	100,000
National Advisory Committee for Aeronautics	260,000
Total	$1,565,014,260

The aircraft program is behind schedule. Present facilities must be speeded up. At the same time, increased sources of supply must be developed. Additional airplanes and engines are under consideration, are in process of design, and in some cases the first experimental planes and engines have been built. Production must be gotten for these new types in plants which have not yet been utilized.

Active steps are being taken by the Government, through the Post Office Department, and other departmental agencies, by Chambers of Commerce throughout the country, by corporations and individual groups looking toward the commercial era of aeronautics. The actual opening of this era will take place this spring, when the airplane postal route between New York and Washington will be inaugurated.

With new appropriations of $1,565,014,260 for Army and Naval aeronautics becoming available, the next six months will see an expansion which was not even contemplated when the unprecedented sum of $640,000,000 was appropriated last August.

Our Service Department is well equipped to give any information wanted. Your inquiries will receive prompt attention. Write to

Aviation and Aeronautical Engineering

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THESE models were designed by members of the Gillette Organization who have seen service with the Colors and know what the soldier is up against.

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The Gillette is the one razor for the man who is doing things—the one razor with world-wide use and reputation.

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Our Paris Office carries stocks—is constantly supplying the American Expeditionary Forces. Gillette Safety Razors and Blades on sale everywhere in France, England, Italy and the Eastern battle fronts.

The Minute a Man Puts on a Uniform

The fighting man doesn't want to dawdle around. He wants to do a thing right—and get it over with.

That's why the boys in the Service, the world over, are using the Gillette—the "once-over razor."

The Gillette saves from five to ten minutes a shave — no strops or hones to clutter up the kit — blades always sharp — always ready — No Stropping — No Honing.

The Gillette is the real service razor — 100% efficient on any kind of beard or skin — under every possible climatic condition, in any part of the world — whether in hot or cold, or hard or soft water.

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The new U. S. Regulations say that every man called to the Colors must have a razor — a razor that will meet all the demands of a soldier's life.

Every man under the Colors needs a Gillette.

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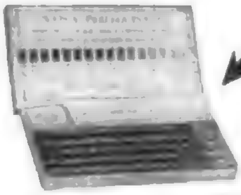

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Names of Advertisers in this issue are printed in capitals. See Index to Advertisers on page 332

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- Dewey Aeroplane Co.
- Engel Aircraft Co.
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- Fisher Body Corp.
- Fowler Airplane Corp.
- Gallaudet Aircraft Corp.
- Heinrich, A. S., Corp.
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- Lawrence-Lewis Aeroplane Co.
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- Loening Aeronautical Eng. Corp.
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- Michigan Aircraft Corp.
- ORDNANCE ENG'RING CORP.
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- Detroit Gas Turbine Corp.
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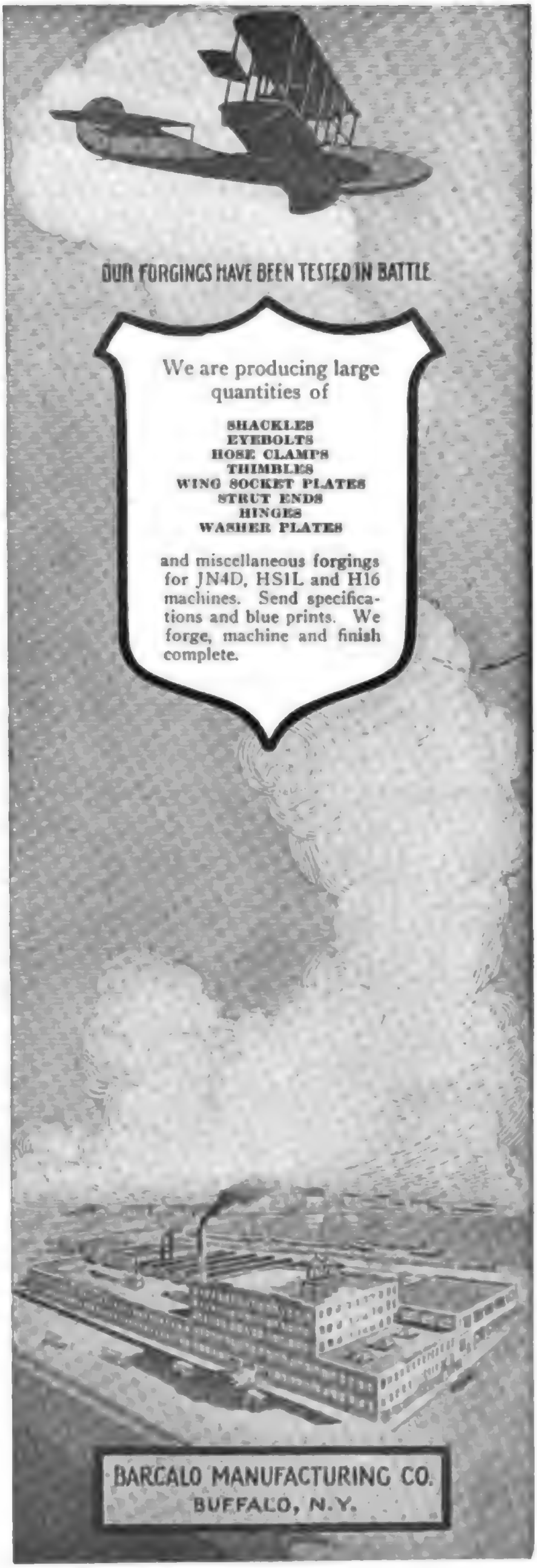

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(Continued from page 319)

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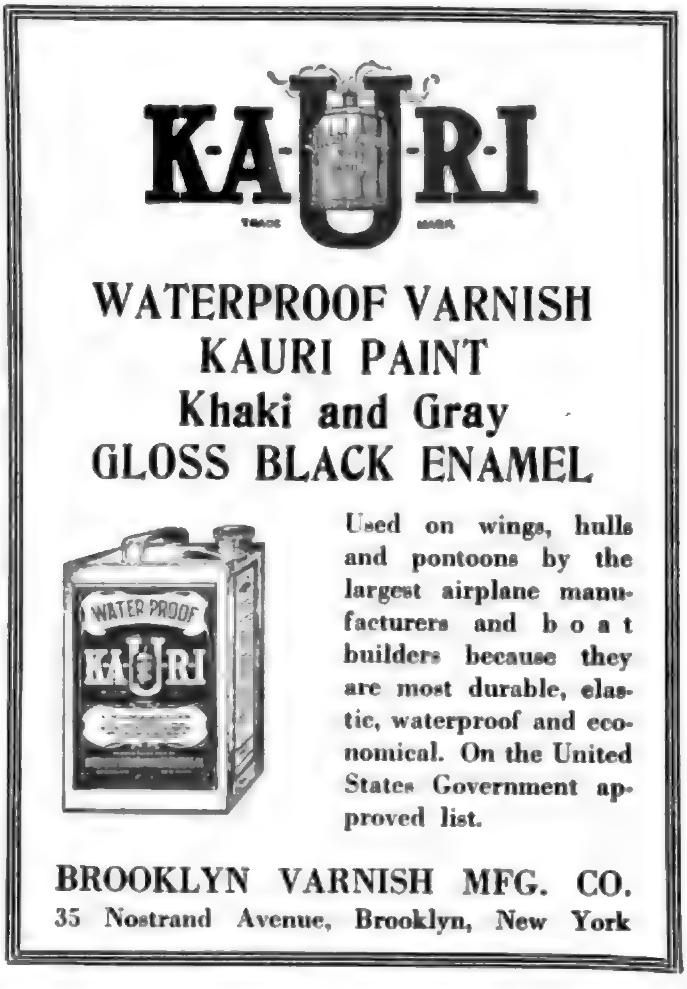

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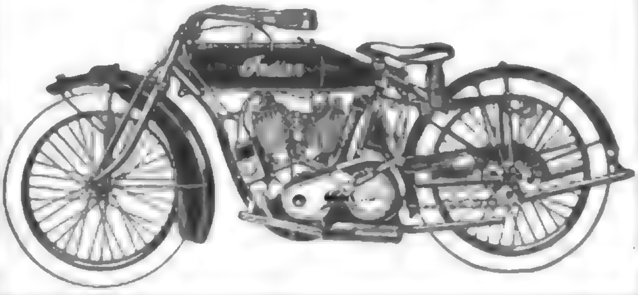

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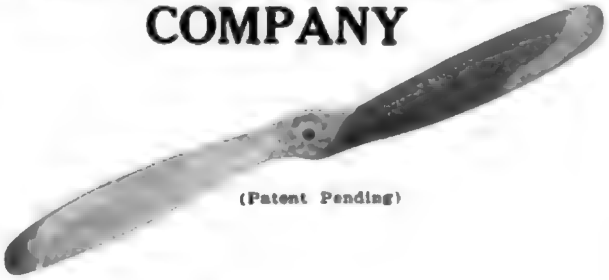

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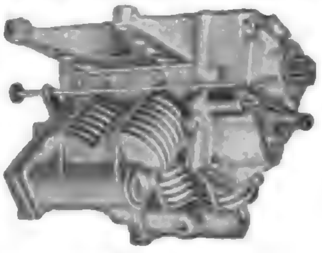

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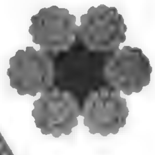

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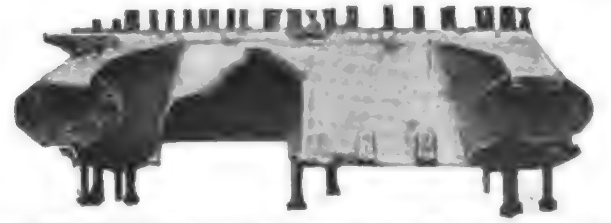

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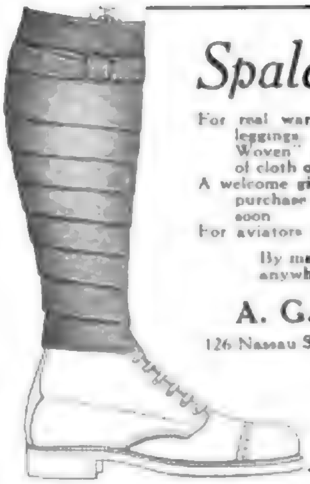

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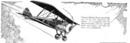

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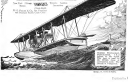

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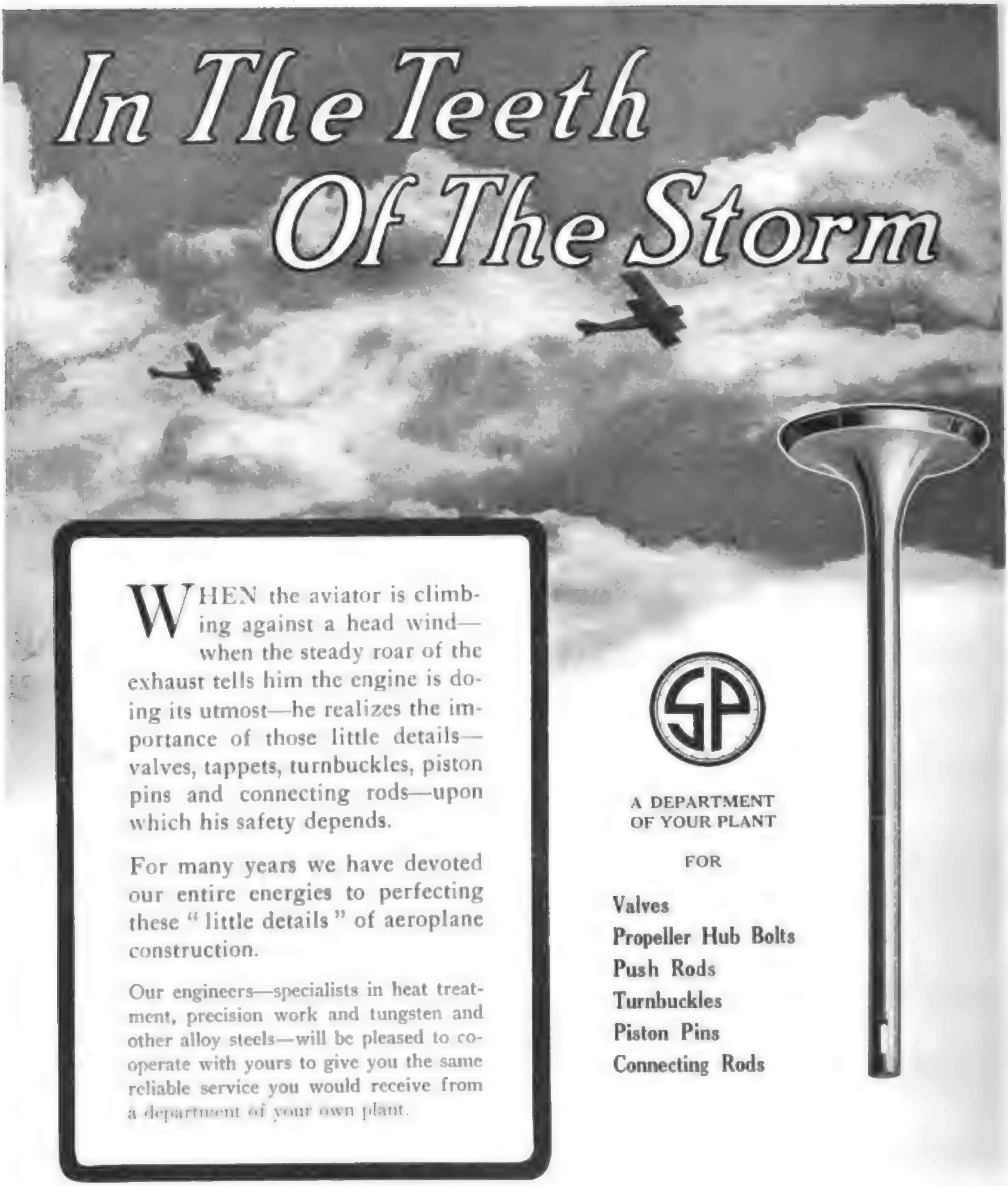

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VOLUME IV
Number 6

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SPECIAL FEATURES

THE USE OF CORK IN AERONAUTICS
THE USE OF JIGS IN AIRPLANE MANUFACTURE
THE MODEL C.V ALBATROS BIPLANE
AIRCRAFT SITUATION FROM A MANUFACTURING VIEWPOINT
SENATE COMMITTEE RECOMMENDS SINGLE AIRCRAFT HEAD

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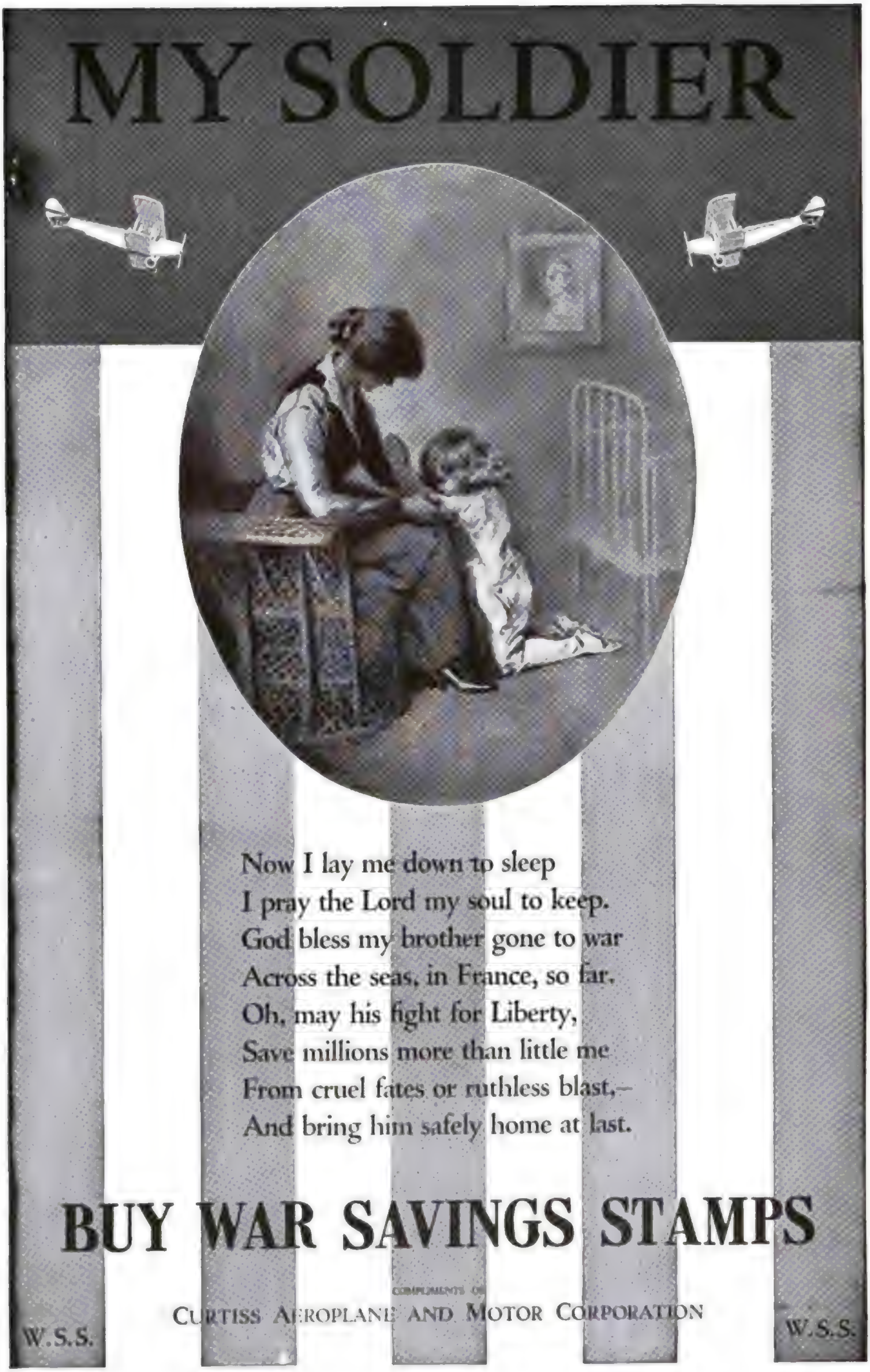

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Vol. IV April 15, 1918 No. 6

The Use of Cork in Aeronautics

By Arthur K. Barnes

Armstrong Cork Co.

Designers, builders, and users of aircraft have all gained materially by the experience of men who have played an important part in the development of the internal combustion engine as used in the automobile industry. Each material which enters into the construction of gas engines has played its part toward making these engines give more dependable performance and last longer than they formerly did.

While gaskets may not be considered as relatively important in motor construction, they at least deserve the careful consideration of engineers who desire to eliminate the leakage that is so common where ordinary fibrous materials are used. For this reason, it may be well to see just how cork has become a factor in the automobile field, and promises to become equally important in aeronautics. Cork has for a long time been manufactured into specialties for motor cars and its success in this field is best evidenced by the growing use of cork floats for carburetors, gasoline tanks, oil gauges, and cork composition gaskets and washers. Remarkable progress has been made in the development of cork compositions which would prove satisfactory in all cases where the temperature did not exceed 212 deg. F. To be satisfactory in service, such a material has to be impervious to oil, gasoline, grease and water, so that it may be kept in contact with these liquids for a long time without losing its effectiveness as a sealing agent.

The Oak Cork—A Native of Spain and Portugal. The Outer Bark of this Tree is the Cork of Commerce

Cork Composition Gaskets

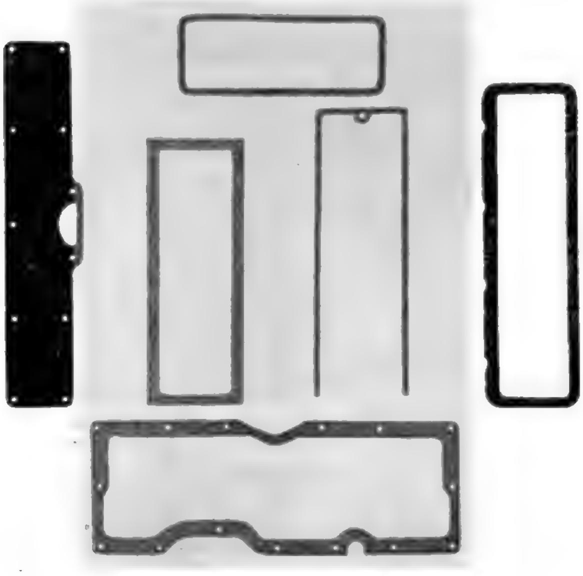
The natural elastic properties of cork are increased in the manufacture of cork composition gaskets, and this quality makes them especially efficient when used between rough, uneven surfaces. Therefore, where cork gaskets are employed, it is unnecessary to machine the flanges of the castings, or pressed steel stampings. The elasticity of cork gaskets is permanent. Since age will not harden the material. Furthermore, cork is naturally non-absorbent and will not become saturated by the action of liquids. It is unnecessary to exert excessive pressure on these gaskets to insure tight joints. With fibrous materials, which are admittedly absorbent, seepage is bound to occur, regardless of how tight a joint may be pulled up. Since oil leakage is a recognized source of expense and annoyance, and the users of gas engines have come to demand tight joints, the use of cork gaskets has been found to be a most inexpensive and, at the same time, a most efficient remedy for this trouble, especially where pressed steel pans and covers are employed.

The constant resilience of cork to pressure has the effect of a lock washer in keeping the bolts tight. As a result, motors equipped with cork gaskets are free from the rattle which often develops from vibration. This is more noticeable, of course, in high-speed motors such as are necessary for aviation purposes. Then, too, fewer bolts and bolt holes are required because very smooth surfaces and excessive pressure are not needed. This condition is doubly advantageous, as it gives greater strength to the metal parts and eliminates considerable machining and assembling work. The savings thus effected are often sufficient to make up for the additional cost of the gaskets themselves.

One of the most successful uses of cork gaskets has been between crank case and oil pan. These gaskets should be thick enough to make a good fill between bolt holes with a moderate amount of compression. Extra pressure may be added if desirable, since the cork will compress to the thickness of paper around the bolts. Any spring which may be present in the metal is taken up by the elasticity of the cork, so that tight joints are insured not only during bench tests, but in actual service as well.

If boiling water or steam is kept in contact with the flat face of a cork gasket for any length of time, damage results. Where these gaskets are used between metal surfaces under pressure, however, they will withstand the temperature of boiling water or slightly higher. This is proved by the successful use of cork gaskets between the top and bottom plates of assembled radiators on motor trucks, and also between pressed steel water outlet and inlet manifolds, baffle plates, and motor head stampings.

Some other applications of cork gaskets are recommended by prominent motor builders, as a result of their experience. On cover plates for timing gears, valve compartments, transmissions, oil pumps, crank case accessories, clutch and fly wheel hand-hole covers, carburetor intake manifolds, differential housings, and various other parts, cork gaskets have stood up most satisfactorily under all kinds of service tests. They are easily applied with a thin coating of shellac or waterproof cement, spread over one of the contact surfaces. Care should be taken against the use of too much cement, since it will squeeze through the bolt holes and cause the gasket to stick on both sides instead of one. Before the parts are assembled, the gasket should be weighted down until the shellac is thoroughly dried.



Valve Cover Gaskets

Other Uses for Cork

There is a growing use of composition cork washers, which prevents rattling and the entrance of dust and dirt. They are also used in stuffing boxes where the speed of the shaft is not rapid enough to generate heat greater than that of boiling water. When used for purposes of this kind, cork washers not only keep dust and dirt outside, but prevent leakage of oil and grease.

Cork gaskets are also being used to prevent fan belts from slipping. It is needless to mention the undesirable action of a belt which slips on a fan pulley and allows the motor to become heated. If the pulley rim is covered with cork the fan will be driven at full speed, all the time, without slippage.

Besides being used for gaskets, cork is manufactured into floats for carburetors, oil gauges and gasoline gauges. These are most always made of natural cork rather than of a composition, but their manufacture is necessarily varied because of the individual specifications to be followed. To give the best results, these floats should be heavily coated with shellac and thoroughly dried before being used. Natural cork is often utilized for clutch inserts, plugs for wire conduits and spark plug holes, etc. Strips of natural cork or of cork composition are often used as a cushion in body joints, and it seems reasonable to believe that this use could be profitably promoted in the construction of airplanes.

Radiator Inlet Elbow Gasket
Fly Wheel Cover Gasket
Oil Regulator Gasket
Oil Pump Pad Gasket
Carburetor Manifold Gasket
Transmission Cover Gasket
Radiator Cap Gasket
Transmission Cover Gasket

Miscellaneous Gaskets

While it has not yet been adopted commercially, composition cork has proved satisfactory in all kinds of shop tests as a material for clutch facings, because of its unusually high coefficient of friction. Cork has showed itself to be superior to leather under the trying conditions of clutch use.

Gasoline and Oil Floats

Carburetor Floats

Natural Cork Floats

All of the uses of cork have not been described here by any means, but a fair idea has been given of the functions which it performs in motors. For the benefit of those who may not be familiar with cork as a natural product, it may be said in conclusion that it is the outer bark of the cork oak tree, which flourishes in Spain, Portugal, and other Mediterranean countries. This bark is the most valuable part of the tree and is removed every eight or ten years. The tree begins to produce its best bark at the age of forty years. In stripping it, great skill is required to prevent injury to the inner skin, for such injury might kill the tree. Cork bark varies from one-half to two inches in thickness. One tree yields from 25 to 200 pounds at a stripping.

Aeronautical Patents

ISSUED MARCH 5, 1918

1,258,279—To Frederick J. Veitch, New York. Airplane.

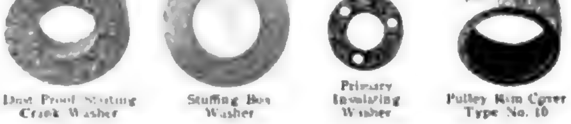
1,258,356—To Albert W. Myers and Robert R. FitzGerald, Ottawa, Ont., Canada, assignors to Albert W. Myers, Ottawa, Ont., Canada. Aerial Machine.

MARCH 12, 1918

1,258,743—To Richard Burchill, Tampa, Fla. Trench destroyer and army destroyer.

1,258,943—To Edmund Hugh Pryce, New York, N. Y. Flying machine.

1,259,083—To Isaac Covino, West New York, N. J. Airplane.


Dust Proof Starting Crank Washer
Stuffing Box Washer
Primary Insulating Washer
Pulley Rim Cover Type No. 10

Washers and Pulley Rim Cover

ISSUED MARCH 19, 1918

1,259,578—To Mitro Wozny, Cleveland, Ohio. Balloon-vehicle.

1,259,804—To Francis A. Thornton, Richmond Heights, Mo. Aerial Machine.

ISSUED MARCH 26, 1918

1,260,474—To Frank Stevens, New York, N. Y., assignor of one-half to Julia Stevens, Niagara Falls, N. Y. Parachute case or envelope.

1,260,917—To Franklin William Lake, Kingston, Ontario, Canada. Airplane.

1,260,957—To Reuben B. Benjamin, Chicago, Ill., assignor to Benjamin Sellar Mfg. Co., Chicago, a corporation of Illinois. Aerial top.

The Use of Jigs in Airplane Manufacture*

By R. Borlase Matthews, Wh. Ex., A.M.I.C.E., M.I.E.E., F.AE.S.

A new industry calls for new methods—*autres jours, autres mœurs*—and the airplane industry is therefore not exceptional in demanding many departures from recognized woodworking practice. In the first place the number of machines required today is so large that their construction should be described as a manufacturing rather than a building operation. That is to say, they should preferably be almost entirely put together by the aid of accurate machinery instead of being dependent to such an extent upon the skill of the individual workman, in trying and fitting one part to another until the whole is built up. In this connection it may be remarked that the design of the metal fittings for airplanes is not such as to call for any radical departure from previous high class small metal working practice. It is the woodworking side of the business which presents the new scope for initiative. It is this latter aspect, therefore, which will be considered here.

The underlying ideal of the modernized system now advocated is that the arrangement of the work and the facilities for economically carrying it out should be planned and designed in the office as distinct from the shops where the actual work is done. For a great number of years it has been realized in engineering establishments that drawings are essential and economical, likewise sooner or later it will be appreciated that drawings of jigs and fixtures are just as necessary.

It may be mentioned in passing, that since the subject is treated as a whole, all the points raised, would obviously not necessarily be applied to the manufacture of one particular type of machine, as so much depends upon circumstances, the size of the order, the probabilities of modifications in design during progress, etc.

Definition of Jigs and Fixtures

The distinction between a jig and a fixture is not an easy one to define, as it is difficult to say where one ends and the other begins. A jig is a device which either holds, or is held on to the work, and at the same time incorporates guides for the various cutting tools; whereas a fixture holds the work while the cutting tools are in operation, but does not contain any special arrangements for guiding the cutting tools. In other words, a fixture is usually a device which must be entirely held or fixed to the machine on which the operation is performed. The term fixture is often, however, also applied to assembling arrangements of larger size, which form complete units in themselves and are generally permanently attached to concrete foundations. Gages must, of course, not be confounded with jigs.

A Comparison Between Engine and Airplane Manufacture

In manufacturing engines in quantities it has long been the practice to use jigs and fixtures in order to speed up production and also to ensure correctness of output. But up to the present, in airplane manufacture, this practice has not been adopted to such an extent as it might have been, with the result that it takes very much longer to turn out an airplane than is necessary. This delay arises, both in production of detail parts and also in the assembly of units and complete machines. Considerable time is lost throughout, in trying and fitting the parts into their correct relation, owing to errors in making the details.

For example, assume that in an engine two parts are required to be bolted together. These parts are not clamped together and then drilled both at the same time, nor is one part drilled and the other clamped up to it and drilled through the first. Both parts are drilled separately in jigs. This may be done in a separate department, or even in a separate factory, and still the parts will bolt together in their correct relation.

But in the majority of airplane works quite a different state of affairs exists. Take, for example, the case of spars which have to have metal brackets attached to clamp up to other parts. Here the metal parts are placed over the spars when they have been put in position relative to other parts. The spar is then drilled through holes already drilled in the metal parts. This entails much difficulty, because the job is inaccessible; it also promotes inaccuracy, owing to the operator having to drill from both sides to ensure that there will be a clear way for the bolts through both sides. All this troublesome work and subsequent delay would be avoided were the spars and metal parts drilled in jigs. All that would then be necessary would be to push the bolts and tighten up.

Again, take the spindling of spars. For the sake of comparison, the milling of straight metal parts may be considered, when the work travels on a horizontal table against the cutter. Here the length to be machined is controlled by stops. In the spindling of spars the job should be placed in a jig having stops upon it, so that it is impossible for the cutter to operate except where it is so desired. By proper design of the jig, the cut out portions will come in correct relation to the overall length and depth.

In cutting form or taper shapes, as, for example, the nose pieces on rotary engines, forming plates are used to compel the tool and the work to move in such a manner that the desired finished form is arrived at. This principle might well be adopted in woodworking, when parts have to be spindled to some special form or taper. The jig would be made with a "former" for bearing against the spindle, which will only allow the cutter to operate in such a way as to produce the desired shape.

The "former" idea should be extended to cover work on the band saw, either for roughing to shape or for finished work when the saw finish is good enough.

For the use of such "forming" jigs on spindling machines, the "former" should bear against a ball bearing embracing the spindle. This will very much reduce the wear on the "former" and so ensure a much longer life for the jig as regards accuracy.

Of course, these "formers" entirely do away with the necessity for marking out shapes, entailing, as the latter operation does, a great amount of time.

The various units that go to make up a complete machine should be assembled in a jig. The jig should hold each unit by at least two locating points. The units, when held in the jig, will all come into their correct relative positions. All that will then have to be done will be to bolt up, through holes drilled in the jigs used for making the parts.

Careful consideration as to the cost of production must be given before setting about the design of a jig or fixture, as obviously it is absurd if the cost of the jig is in excess of the anticipated gain. The only exception that would permit of the employment of a jig, which did not comply with the above conditions, is where accuracy of parts is of such importance as to make interchangeability of these parts absolutely essential.

Time and Cost Saved by Use of Jigs

As an illustration of time saving, many airplanes could be made in three-fifths of the present time required, if proper jigs and fixtures were in existence. The cost would be reduced by something like 25 per cent, this estimate being based upon a small number of machines, say 250. On a larger number, say 1000, the saving in labor would be about 50 per cent, and naturally the saving in labor means increased speed in production.

As a detail example of economy the elevator of a certain machine used to cost in labor alone £2 10s. 0d.; this was immediately reduced to under a sovereign on the introduction of proper jigs. Many other similar cases could be cited.

Jig and Fixture Drawings

A modern airplane requires at least 1200 jigs and fixtures. It is obvious that to make so large a number with accuracy, and to ensure that the right number are ordered, these jigs should be made to drawings. At present the comparatively few jigs that are employed are, as a rule, made to the shop foreman's more or less crude ideas. It therefore follows, that when some machine or parts of machines are made by more than one sub-contractor, there will, assuming all sub-contractors work to jigs, be as many different types or styles of jigs to do the same job. Each of these different jigs, to do the same job, is the result of separate thought.

Here, obviously, is an opportunity for economizing time,

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* A paper read before the Aeronautical Society of Great Britain.

As regards lateral control, the general arrangement of this is indicated, in diagrammatic form, in Fig. 21. From the control lever the direct cable passes over a pulley on the transverse shaft, along through the bottom wing, around another pulley in the wing, and hence to the rear half of the aileron crank lever. The return cable runs from the front half of the aileron crank lever, around another pulley in the lower wing, through the wing and through the transverse shaft to a pulley on the other side of the control lever, and hence to the screw on the control lever. The details will be clear from Fig. 18.

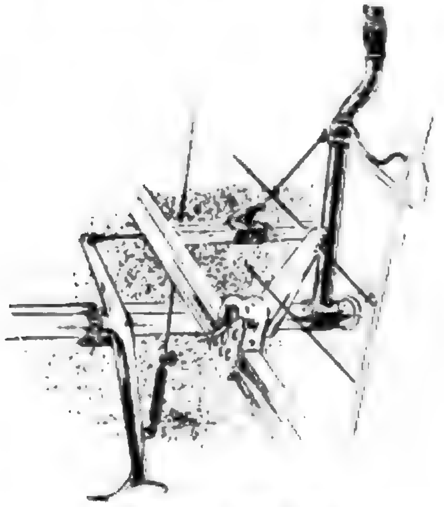


Fig. 19. The Claw Brake (Diagram)

The foot-bar operating the rudder is mounted on a pyramid of steel tubes, and the rudder cables are taken not from the foot-bar itself, as is generally done, but from a short lever projecting forward at right angles to the foot-bar. From this lever the cables pass over pulleys and to the cranks on the rudder. It will be seen that provision has been made for making adjustments of the foot-bar to suit pilots of different height by fitting an extra foot-bar. If the machine is to be flown by a taller pilot this is removed and the main foot-bar used. Wire clips are provided, it will be noticed, for accommodating the pilot's heels so as to prevent his feet from slipping off the foot-bar.

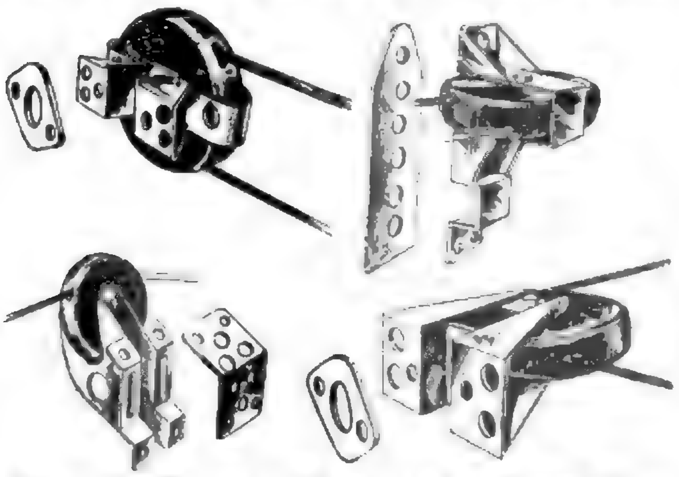


Fig. 20. The Pulleys and Brackets of the Control Cables

As in the majority of German machines, provision has been made for locking the control lever in any position, either flying level, climbing, or descending. This is accomplished by means of a collar free to slide along the control column, but being split and provided with a bolt for tightening up when the collar is locked in position on the control column. Anchored to this collar by two screws is a fork end, from which a tube runs down and forward to terminate in a ball and socket joint secured to the bottom of the body. This ball and socket joint enables the control column to be moved freely in any direction, and to allow it to be moved from side to side, even when the forward movement of the column is prevented by locking the collar. In this manner the pilot can lock the elevator, while operating the control column from side to side for lateral control with his knees.

As far as can be ascertained, although the machine gun was not in place on the machine as exhibited, one synchronized machine gun was fitted, resting on top of the body on the right-hand side. The pilot operated this gun by means of the trigger on the hand-grip of his control lever, which is shown inset in Fig. 18.

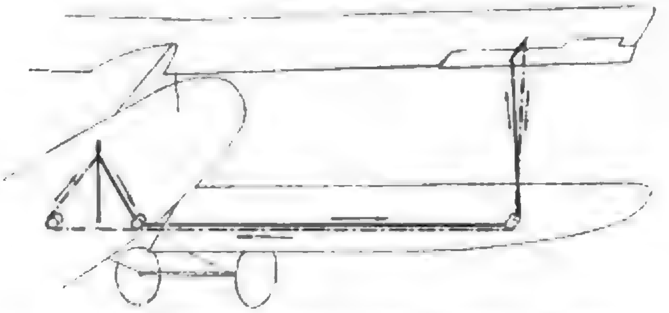


Fig. 21. Diagram of the Aileron Control System

While on the subject of controls, reference might be made to the crank levers on the elevator and rudder. These are shown in Fig. 22, from which their construction will be evident. The crank lever of the elevator has projecting from it a tapering tube running to the trailing edge of the elevator. The tubular rudder post is working in bearings similar to those previously described when dealing with the hinges for the elevator. At the bottom the rudder tube fits into and is supported by a socket carried on a clip bolted to one of the transverse bulkheads of the body. A peculiarity characteristic of the Albatros is the method of attaching the control cables to the crank levers. A socket is formed in the end of the crank lever, and into this fits a cup-shaped piece of steel machined on one of the bolts of the wire strainers, much in the same manner as the terminal attachment of the main lift cables. Thus any vibration in the control cable is not transmitted to the crank lever, the cup-shaped head of the turnbuckle bolt being free to move in its socket in the crank lever.

Reference has already been made to one part of the armament of the Albatros, namely, the synchronized machine gun operated by the pilot from the trigger on the main control column. In addition, there is a movable machine gun mounted on the usual gun ring in the rear cockpit (Fig. 23). The gun ring itself is built up of thin, three-ply wood, and runs on small rollers on its support so as to reduce friction. It is prevented from tilting up by wooden angle-pieces screwed to its underside and overlapping the fixed support. The whole arrangement looks somewhat clumsy, but is apparently quite light, and the strength is probably reasonably good, as the three-ply of which the gun ring is built is made up of different curvatures, each of which tends to strengthen the others.

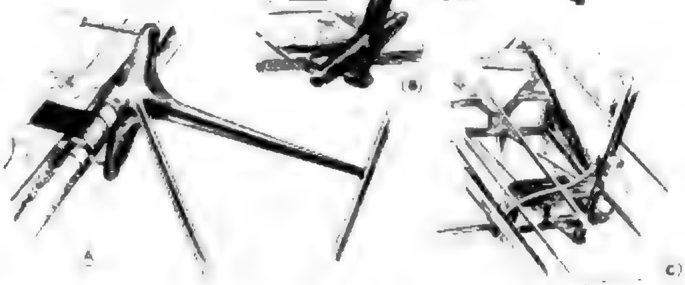


Fig. 22. The Elevator and Rudder Crank Levers [(A) Elevator, (B) and (C) Rudder]

The machine gun is supported on the gun ring by a swiveling fork, which can be raised and lowered as required, and which can be locked in any desired position by the locking arrangement indicated in the sketch of the general arrangement. In addition to its circular movement integrally with the gun ring, the machine gun may be swung laterally on its pivot in the gun ring. Here also a locking device is provided in the shape of a split collar locked by an L-bolt, as shown in one of the insets. The other inset in Fig. 23 shows the lever by means of which the gun ring is locked in any desired position. A rocker arm composed of two steel strips is pivoted in its center on a pillar projecting downward from the gun ring. At one end this rocker arm carries a plate welded to the two steel strips of the rocker, and at the other it carries the hand lever, which is so formed and pivoted as to give an eccentric movement when the lever is swung through an arc. The *modus operandi* will be clear from the sketch. When the gun ring has been swung around to the desired position, the hand lever is pushed down; in so doing the eccentric forces the inner end of the rocker down, thus causing its outer end carrying the flat plate to move up against the fixed support for the gun ring, and thereby locking it. A pull on the lever instantly releases the gun ring if it is desired to swing the gun around to another quarter.

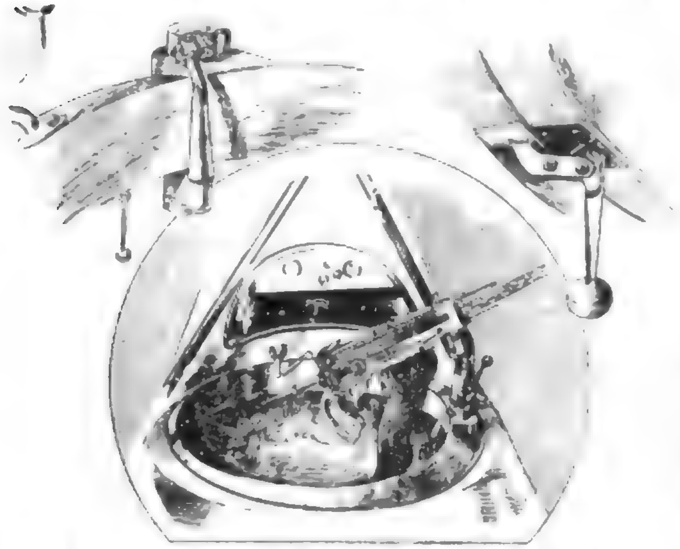


FIG. 23. THE MACHINE GUN MOUNTING ON THE AFTER SEAT

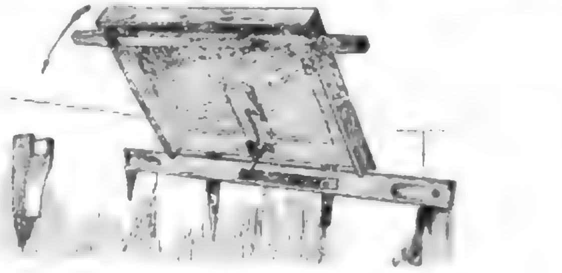


FIG. 24. THE HINGED SEAT OF THE AFTER COCKPIT

As presumably it frequently happens that the gunner wishes to fire from a standing position, his seat has been so arranged as to swing into a vertical position as soon as it is relieved of his weight. This is accomplished by means of a spring under the seat (Fig. 24). A strip of wood runs transversely under the seat and projects a short distance on either side. These projections rest, when the seat is in a horizontal position, in brackets secured to the sides of the body.

(To be continued)

An Early Helicopter

Sir Charles A. Parsons, whose name is prominently connected with the steam turbine, is also one of the pioneers of aeronautics. As far back as twenty-five years ago Mr. Parsons made a series of experiments with a small steam helicopter which raised itself about 12 ft. from the ground.

A description of this interesting forerunner of the vertical lift machine is given by Mr. Parsons in *Aeronautics* in the following terms:

In the summer of 1893 I made some experiments on the effect of steam-jacketing small steam-engine cylinders by placing the whole of the cylinder and valve-chest inside the boiler. The increase of economy was so marked that I was led to try whether a small toy engine could be made to sustain its own weight in the air by the lifting power of an airscrew on the crankshaft.

The boiler is of seamless steel, 2½ in. diameter, 14 in. long, and .01 in. to .015 in. in thickness; the steam cylinder, single acting, 1¼ in. diameter by 2 in. stroke, and about .03 in. thickness of tool steel; the piston is of thin cup form, also of tool steel; the admission valve is cylindrical, 3/16 in. diameter, cutting off at ¾ stroke. The whole of the valve and cylinder are within the boiler. Some parts of the engine were soft soldered and some hard soldered; the screw is of cane covered with silk. The working pressure was limited to about 50 lbs. per sq. in. The total weight of the apparatus, with water, is 1¼ lb.

Steam was raised by placing the boiler over a spirit-lamp, and when 50 lb. was registered on the gage, and the engine started, it raised itself in the air vertically to a height of several yards. The revolutions of the engine were about 1200 per min. and the i.h.p. ¼ hp.

The same engine was then mounted on a framework of cane, covered with silk, forming two wings of lift span, and a tail, the total area being about 22 sq. ft. The total weight was now 3½ lb., and when launched gently from the hand in an inclined horizontal direction it took a circular course, rising to a maximum height of about 20 ft. When the steam was exhausted it came down, having traversed a distance of about 100 yd.

Considering the primitive construction of the apparatus, the result clearly showed that flights of considerable distance, possibly some miles, were quite possible with small, economical steam engines mounted on airplanes. The boiler was also found to be able to steam the engine continuously by using methylated spirits instead of water in the boiler, and burning the exhaust as fuel; but when in flight the force of the wind extinguished the flame. It was clearly seen by the experiment that for practical, commercial success of this class of steam apparatus an air condenser is essential, as the weight of water used in a few minutes' run equals the total weight of engine and boiler. Without a condenser the length of flight must necessarily be limited to a very few miles, and it would seem that the chief problem that workers in this field have to solve is to obtain an efficient and light dry-air condenser.

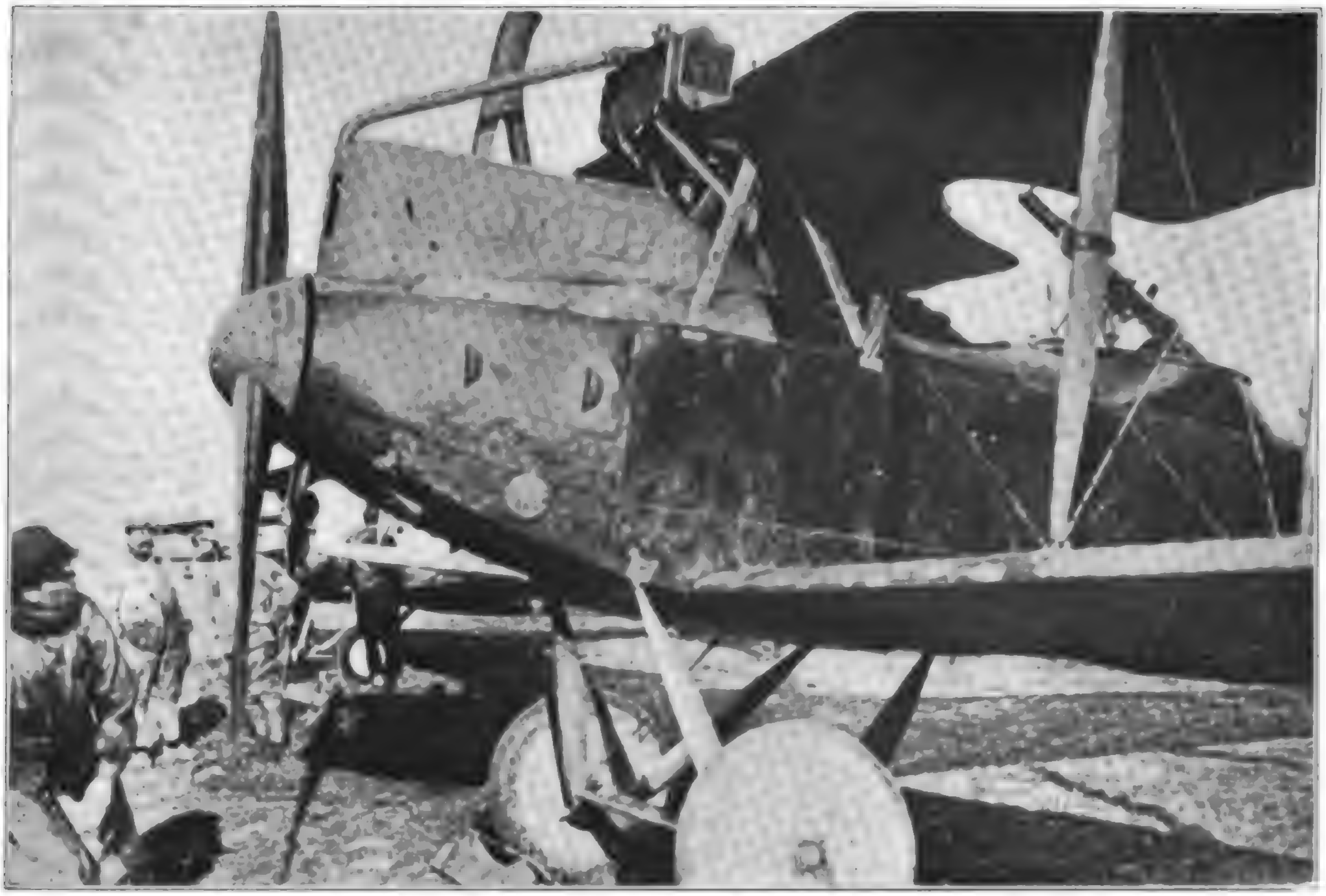
In view of the presently reviving interest in the helicopter, the opinion of Mr. Parsons on this type of aircraft is of particular value. This early investigator of the problem says:

"The helicopter, which is a machine that will lift itself in the air without horizontal motion, has been the dream of many inventors, and many have thought that by suitably shaped propellers success might be attained; but to those who have closely observed the flight of birds on leaving the ground, it has been apparent that unless an initial horizontal velocity is first attained by running on the ground or by webbed feet against the water, as in the case of a duck or swan; once again a plunge from an elevated position that, without such initial help, the bird has to exert a very abnormal effort to rise at all.

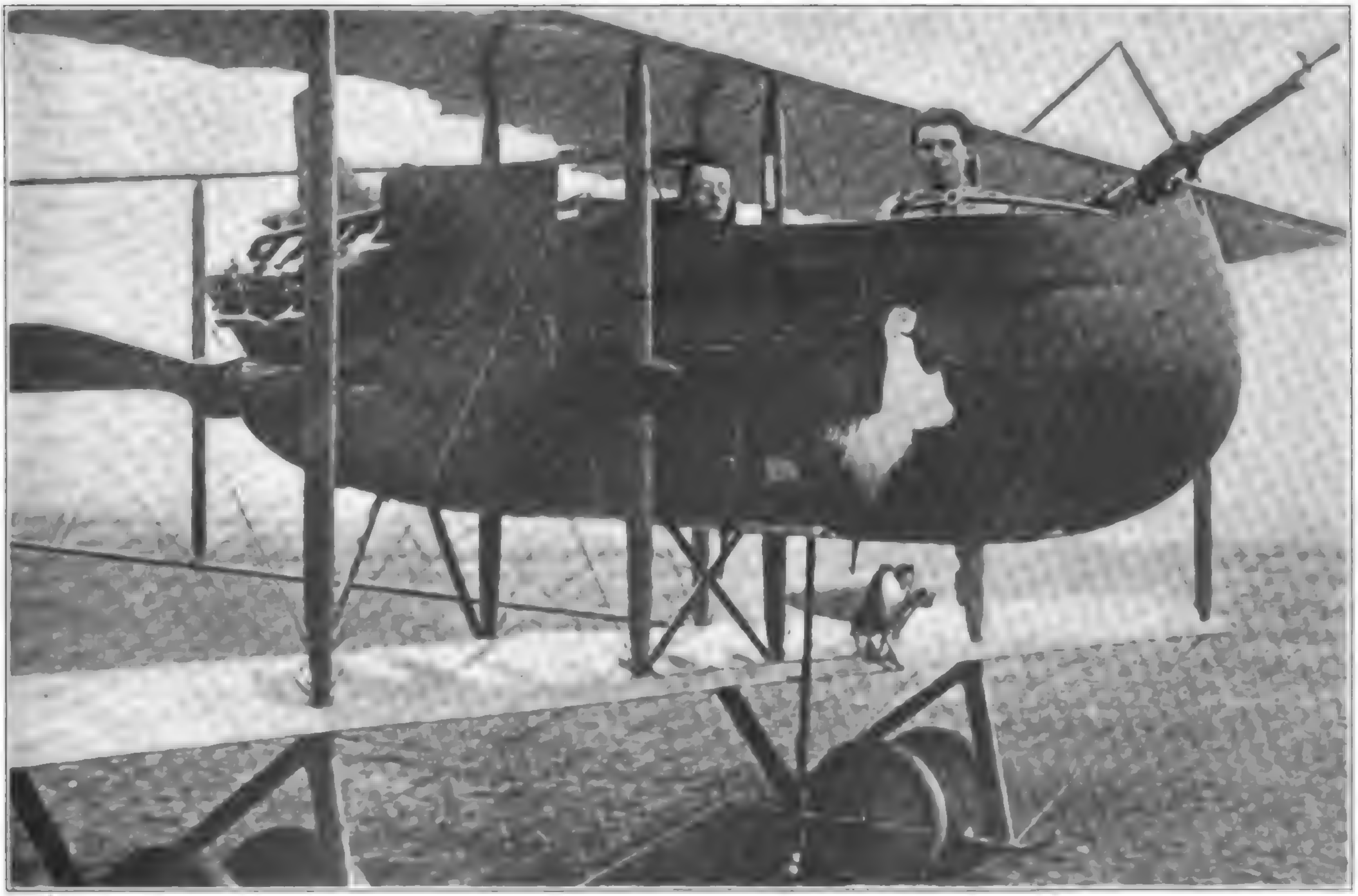
"From experiments I made about 1890, I came to the conclusion that when in steady, horizontal flight, the power required to maintain the motion did not exceed one-tenth of that necessary to rise vertically from the ground.

"If the lifting screw is made very large in proportion to the weight of the apparatus, the slip and the power required for a given weight is diminished, but the apparatus becomes unwieldy, and is readily distorted or upset by wind.

"On the whole, I do not think that the helicopter type of machine is at all promising as a competitor of the gliding machine, which is always coming on to fresh air, which supports it with a minimum of slip and consumption of power."



(C) Underwood and Underwood FORWARD PORTION OF A GERMAN TWO-SEATER FIGHTER



(C) Kadel and Herbert PUSHER BODY OF A FRENCH FARMAN SCOUT

The Largest Cut-Up Plant in the World

By J. Frederic Thornel

Portland Chamber of Commerce

The largest cut-up lumber mill in the world is owned by Uncle Sam and is located at Vancouver Barracks just across the river from Portland, Oregon. It is under the direct control of the Spruce Production Division of the Signal Corps of the Army, Colonel Brice P. Disque commanding.

The main building of the plant is 348 x 400 ft. and the shipping sheds 60 x 500 ft. The output capacity is from 400,000 to 600,000 ft. of airplane stock sizes every twenty-four hours, with three or four shifts totaling about a thousand men. Maximum cutting length for timbers is 40 ft. Each unit of the plant contains two circular saw rigs, one right and one left, carrying 48 in. No. 9 gauge saws.

General View of the Spruce Cut-Up Plant at Vancouver Barracks
Photo Gifford and Prentiss

Arrangement of the Plant

The carriages are three and four block type. Back of the saw rigs are two table edgers, two re-saws and eight trim saws in each of the six units. It is expected that dry-kiln facilities for about 50 per cent of the output will be installed, requiring a boiler capacity of 1500 hp. The entire plant is electrically driven and every safeguard against accidents is given the workmen.

The arrangement of the plant provides for the installation of two locomotive cranes running parallel to the unloading track for the easy and convenient handling of cants from the railroad cars to the transfer cars, operated by gravity into the mill. The outgoing loading track is at the rear of the plant. The locomotive cranes also are used to pile up cants alongside the railroad tracks before they are carried to the mill for resawing. Electric cranes pile up the cants while a system of conveyors under the floor transfers the refuse to the fire-room where it is used for generating the steam for the dry-kilns.

The plant is equipped with twelve pony carriages, which are calculated to give it a daily capacity of 600,000 ft. It is protected by a double line of guards and a great battery of search lights.

The location of the plant is as nearly ideal as any manufacturer could wish or expect. There is just enough slope for natural drainage, adequate fire protection and a complete sewerage system. The housing of the soldiers who will assist in the operation of the plant is in close proximity.

Eliminating Cross-Grain Material

In discussing the spruce that will be worked at this mill one of the men in charge says:

"A considerable supply of hewn, sawed and rived cants are already on the ground and more are arriving each day. The plant will be operated on a twenty-four hour basis, with four crews, working six hours at a shift, with twelve hours off.

"Cross-grain has been one of the chief causes for rejection of airplane material at the Eastern factories. Elimination of cross-grain has therefore been one of our problems. All logs have some taper, and by beginning to saw at the butt end in the usual way you cut across the annular rings, which are parallel to the bark. In order to cut straight grain lumber it is necessary to start at the butt end, cutting, say, two inches in, and then come out at a depth of two inches at the other end of the log. This produces straight grain. This method is not necessary to obtain commercial stock, but the stress which falls upon airplane material makes it absolutely vital that this lumber be sawed to get actual straight-grain stock. This plan must be followed in order to get straight-grain lumber from the mills for the remanufacturing plant.

"At the Vancouver plant the lumber will reach us in the form of flitches four and six inches thick. These will first be surfaced one side by the planers. The grain will thus be brought out clearly, and especially it will then be possible to detect spiral grain, which cannot be passed under any circumstances. With the grain now plainly visible, the next step is the marking of the piece for resawing, which will be done to eliminate all defective portions. The material will then be airplane parts in the rough. The next step is the kiln drying. The material will all be classed as to size in going to the kilns, the larger pieces, which require more time in the kilns, being segregated from the smaller, which will dry faster. Beam stock will take about twelve days and smaller

Loading Lumber at Vancouver Barracks
Photo Gifford and Prentiss

parts seven days. It is probable that a small testing laboratory will be maintained to insure that the material has not lost its strength in drying. Cross and spiral graining are the most treacherous defects that can exist in airplane lumber."

Draft Soldiers Commended

In an address to the soldiers working at the plant Colonel Disque said:

"I have commanded regular troops for a great many years and have never seen a spirit comparable to that which you men have shown in the construction of this plant. You worked for days without raincoats and proper equipment and went right ahead without a grumble, doing it on soldier pay because with the enormous problems our great government has to solve it has been impossible to get the matter of proper pay straightened out. You have not complained about what you did not have, although you did not have raincoats and overshoes part of the time. That spirit from drafted men in the American army speaks well for the saving of our democracy.

"Now men, this plant is yours, yours to run and we expect you to keep it. Do not permit little violations of rules that will creep in sometimes. We cannot afford to take any chance with the continued operation of this plant, now complete. Arrangements are rapidly being completed whereby you men employed in the plant will be given what you were promised when you came, that is the going wages of the community. I think every man here should be proud to belong to this organization and I think all of you feel that this mill, completed in forty-five working days from the time started stands to your credit as a monument to the loyalty and efficiency together of the American soldier of our army today and I am mighty proud to be in command of this organization."

The government is paying for rived spruce $90 per thousand board feet, with a bonus of $30 additional up to June 30. For sawed spruce the price paid is $105 per thousand. Operators are paying to owners of timber land a stumpage of $7.50 per thousand. Of course, all material is accepted only after rigid inspection according to the specifications of the Spruce Division.

In addition to the spruce there have been received in Portland recently orders from the United States, French, British and Italian governments for aircraft material aggregating a total of about forty million feet, part of which already has been shipped. All similar orders placed by foreign governments will be handled on shipping instructions from the Spruce Production Division headquarters.

Rived Oregon Spruce
Photo Gifford and Prentiss

In dollars and cents this industry that is essentially new means more to the entire Pacific Northwest than any other enterprise heretofore or now in existence. Nor is it apt to cease with the end of the war.

We are indebted to *The Timberman*, lumber publication on the Pacific Coast, for the following tables, which are self-explanatory:

What 11,000,000 Feet of Airplane Spruce Monthly Means

To secure 11 million feet of airplane spruce monthly from stands of timber running 10 per cent spruce, assuming that the logs produced would yield 10 per cent airplane cuttings, it would mean that 1,100,000,000 ft. of timber of all kinds would have to be logged monthly, or 13,200,000,000 ft. annually. Computations in tabular form for logs yielding 10 to 30 per cent of airplane cuttings on the basis of 10 to 30 percent stands of spruce are as follows:

Interior View of the Plant
Photo Gifford and Prentiss

COMPUTATIONS FOR 10 PER CENT SPRUCE STAND:

Per cent of airplane cuttings from log.	Ft. to be logged monthly. (all species)	Ft. to be logged annually. (all species)
10%	1,100,000,000	13,200,000,000
15%	[illegible]	[illegible]
20%	[illegible]	[illegible]
25%	[illegible]	[illegible]
30%	[illegible]	[illegible]

COMPUTATIONS FOR 15 PER CENT SPRUCE STAND:

Per cent of airplane cuttings from log.	Ft. to be logged monthly. (all species)	Ft. to be logged annually. (all species)
10%	[illegible]	[illegible]
15%	[illegible]	[illegible]
20%	[illegible]	[illegible]
25%	[illegible]	[illegible]
30%	[illegible]	[illegible]

COMPUTATIONS FOR 20 PER CENT SPRUCE STAND:

Per cent of airplane cuttings from log.	Ft. to be logged monthly. (all species)	Ft. to be logged annually. (all species)
10%	[illegible]	[illegible]
15%	[illegible]	[illegible]
20%	[illegible]	[illegible]
25%	[illegible]	[illegible]
30%	[illegible]	[illegible]

COMPUTATIONS FOR 25 PER CENT SPRUCE STAND:

Per cent of airplane cuttings from log.	Ft. to be logged monthly. (all species)	Ft. to be logged annually. (all species)
10%	[illegible]	[illegible]
15%	[illegible]	[illegible]
20%	[illegible]	[illegible]
25%	[illegible]	[illegible]
30%	[illegible]	[illegible]

COMPUTATIONS FOR 30 PER CENT SPRUCE STAND:

Per cent of airplane cuttings from log.	Ft. to be logged monthly. (all species)	Ft. to be logged annually. (all species)
10%	[illegible]	[illegible]
15%	[illegible]	[illegible]
20%	[illegible]	[illegible]
25%	[illegible]	[illegible]
30%	[illegible]	[illegible]

Selective Spruce Logging

On the basis of selective spruce logging, i.e., the removal of the spruce trees only, we have calculated the amount of spruce timber that will be necessary to be logged to yield 11 million feet of airplane material monthly:

Per cent of airplane cuttings from log.	Ft. to be logged monthly. (Spruce only)	Ft. to be logged annually. (Spruce only)
10%	[illegible]	[illegible]
15%	[illegible]	[illegible]
20%	[illegible]	[illegible]
25%	[illegible]	[illegible]
30%	[illegible]	[illegible]

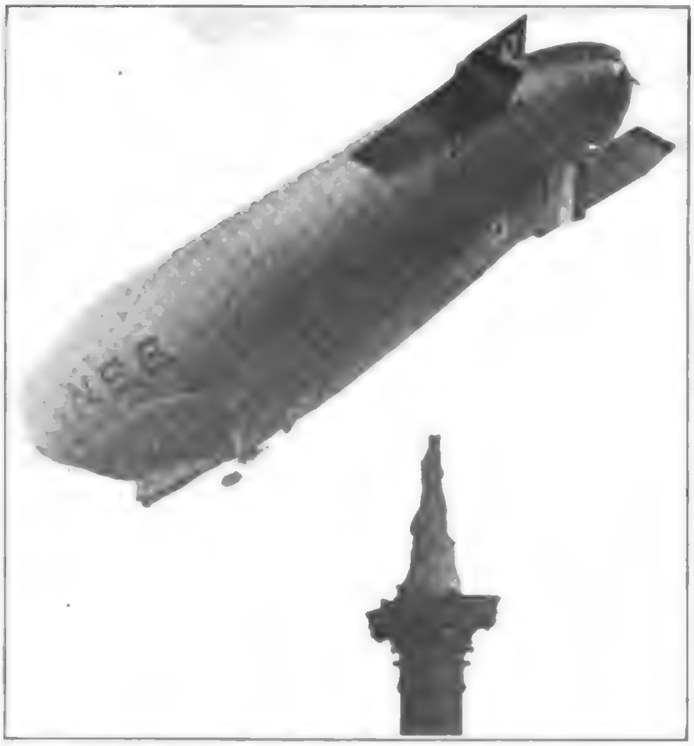
Extract from comparative table compiled by Forest Products Laboratory, United States Forest Service, Madison, Wisconsin:

PROPERTIES OF WOODS FOR USE IN AIRPLANE DESIGN

(Strength Values at 15 Per Cent Moisture)

	Spruce, Red White, Sitka (Picea Rubens, Canadensis, Sitchensis.)	Pine, Western Yellow or Calif. White Pine (Pinus Ponderosa.)	Pine, Sugar (Pinus Lambertinna.)	Fir Douglas.
Specific gravity based on volume and weight when oven-dry:				
Average	41%	42%	39%	52%
Minimum	36%	38%	36%	47%
Weight at 15% moisture:				
Lbs. per cubic foot	27	28	27	34
Shrinkage from green to oven dry condition:				
Radial.	3.8%	3.9%	2.9%	5.0%
Tangential	7.5%	6.4%	5.0%	7.9%
Static bending:				
Fiber stress at elastic limit. Lbs. per square inch	5,100	6,800	5,300	6,800
Modulus of rupture. Lbs. per square inch....	7,900	8,700	7,400	9,700
Modulus of elasticity. 1,000 lbs., per square inch	1,300	1,300	1,100	1,780
Work to maximum load. Inch lbs. per cubic inch.	7.4	6.7	5.0	7.2
Compression parallel to grain:				
Maximum crushing strength. Lbs. per square inch	4,300	5,000	4,300	6,000
Compression perpendicular to grain:				
Fiber stress at elastic limit. Lbs. per square inch	500	640	540	750
Shearing strength parallel to grain:				
Lbs. per square inch	920	1,040	950	1,020
Hardness side:				
Load required to imber. 0.444 inch ball one-half its diameter. Lbs.	430	430	410	580

The Latest in Airship Design



British Naval Airship of the N. S. (North Sea) Class Over Trafalgar Square—This Vessel Shows Clever Combination of an Astra-Torrès Hull with a Forlanini Type of Car

Central News Photo Service

Book Reviews

Cavalry of the Clouds. By "Contact" (Capt. Alan Bott, M. C.). Doubleday, Page & Co., Garden City and New York. ($1.25. 266 pp.)

Among the large number of books dealing with aerial warfare which have appeared since the outbreak of the Great War, a few stand out by virtue of their intrinsic qualities. Some of these will in due time become classics of war flying literature. Cavalry of the Clouds undoubtedly belongs to this class.

The volume reviewed was written by a fighting aviator belonging to a crack squadron of the Royal Flying Corps which, during the battle of the Somme, held the record in the number of its losses. Once eleven of its machines were posted as missing in the space of two days, a circumstance, the author notes, which had never yet been equaled in R. F. C. history. That the squadron possessed an excellent fighting record, even among the enemy, was shown in a letter found on a captured German airman, who referred ot it in the following terms: "The most to be feared of British machines is the Sopwith."

Captain Bott has the rare gift of presenting his subject in a style at once vivid and expressive; one which conveys even to the non-initiated the secrets of war flying in a most thrilling and, at the same time, technically correct manner. Students of aerial warfare will find it worth their while to absorb this book in a thorough way, for it gives in an easily readable style more practical information on aerial tactics than many a more abstruse treatise.

Cavalry of the Clouds is prefaced by Major-Gen. W. S. Brancker, late Deputy Director-General of Military Aeronautics of Great Britain, a fact which vouches for the real value of the book.

Military Observation Balloons (Captive and Free). By Emil J. Widmer. D. Van Nostrand Co., 25 Park Place, New York. ($3.00. 151 pp., 3 plates and 38 ill.).

This book, which is based on the Balloon Manual of the German Army, gives a very comprehensive survey of the manufacture, equipment, inspection and operation of kite-balloons, as well as of the drill and organization of the German balloon troops as it existed prior to the war.

Although the Parseval-Sigsfeld kite-balloon, which is described in detail in the book reviewed, is no longer being used by the aircraft troops of the Allies, its place having been taken by the much handier Cacquot kite-balloon, the basic principles ruling the construction and operation of these craft have remained the same; from which it follows that, since the subject is very capably set forth, the present volume constitutes an excellent text-book on the subject of free and captive balloons.

The Gas Motor. By Max Kushlan, B. S., Ass. M. W. S. E. The Branch Publishing Co., Chicago. ($2.50. 366 pp. and many ill.).

This volume is intended as a practical manual for operators and students of internal combustion engines, and appears to satisfy this purpose as far as automobile practice is concerned, for the greater part of the book is devoted to the study of the automobile engine, though an interesting chapter is set aside for the stationary gasoline engine, and reference is also made to various types of aero-engines. In the latter connection it might be regretted that the author has not seen fit to give a description of a thoroughly modern aero-engine. Such examples as are given are cited in a perfunctory manner and belong mostly to obsolete, or else experimental, types, such as the Vivinus, Farcot, Gobron-Brillé, etc., which naturally are little representative of modern aero-engine design.

Dyke's Automobile and Gasoline Engine. By A. L. Dyke, St. Louis, Mo. (Seventh edition. $3.50. 916 pp., fully illustrated.)

The seventh yearly issue of this reference book on the construction, operation and repairing of automobiles should prove of particular interest to the air mechanic, because it includes, for the first time in the history of this publication, a brief but sufficiently wholesome supplement on aviation. Although but sixteen pages are devoted to this subject, the information given is quite comprehensive, and particular attention is paid to the mechanism of some well-known aero-engines, such as the Monosoupape Gnôme, the Hall-Scott, the Mercédès, and others.

Aircraft Situation from a Manufacturing Viewpoint

For the first time it is now possible to present an authoritative composite of certain constructive ideas of leading aircraft manufacturers as to how quantity production of aircraft may be obtained and obtained quickly. The manufacturers are apparently in accord in the belief that the time has arrived to place the entire responsibility for the development of the air program in the hands of a civilian executive with complete power to make immediate decisions upon engineering and production matters. Their views in this and one or two other respects closely parallel the majority report made by the Military Affairs Committee of the Senate and the forecast of some of the recommendations of the President's special committee investigating the aircraft situation headed by H. Snowden Marshall and published in the New York *Times* of April 13. These views were, however, expressed before the Senate report was published or the Marshall recommendations had been made to the President.

PRODUCTION ESSENTIALS

1.—Orders should be placed at once for a sufficient number of planes to prevent the closing of productive aircraft plants. A continuing manufacturing program should be decided upon without further delay.

2.—Immediate "go-ahead" orders should be given for the completion of a definite number of machines without changes.

3.—Changes and improvements, where indicated by experience or necessity, to be made in the next specific lot of machines.

4.—Full advantage should be taken of the experienced engineering and production experts of the aircraft manufacturers.

5.—Substitution of materials of equivalent physical characteristics and strength should be permitted, when it is impossible to live up to specifications without involving delays.

6.—A direct channel for the constant flow of information from the responsible government official to the contractors should be opened. When an order is placed the manufacturer should be immediately given all available information regarding the particular machine or machines.

7.—Orders for complete machines should be placed with responsible contractors who should be held strictly responsible to the Government under their bonds for the delivery of a definite number of machines.

8.—Simplification of Government cost accounting methods in the plants, so as to eliminate innumerable minor and technical disputes between Government accountants and the manufacturers which result in retardation of production.

9.—Original American creative work and design should be encouraged in every way.

10.—The appointment of a civilian executive in whom may be lodged the entire responsibility for the development of the American air program.

The first and most compelling fact is that one of the largest producing aircraft plants will have to close down within two weeks for lack of orders.

Manufacturers of aircraft as a whole are understood to have practically no *definite* orders at the present time. They must have continuing and overlapping orders to keep their plants running at full capacity; they must also have definite instructions to proceed with the manufacture of machines, orders for which have been *tentatively* placed.

The best machines should be quickly decided upon, a schedule laid out and the way cleared for uninterrupted production of a definite number of planes without permitting the incorporation of changes in that lot. While these machines are being turned out, changes suggested by experience or necessity could be worked out in time for incorporation in the succeeding specific number of planes. The result would be to progressively incorporate the latest improvements without retarding production.

If some definite action is not taken immediately, the result will be to completely disrupt organizations which it has taken the better part of a year to build up, and further serious delay may be looked for in carrying out the airplane program.

Certain manufacturers have been going ahead practically upon their own initiative and at their own risk in their genuine desire to accomplish *something*. They are assuming a risk they should not be called upon to assume.

Advantage has not been taken in the past of the skilled engineering and production forces of the aircraft manufacturers. This has resulted in the suppression of original effort in design and construction. In fact the policy seems to have been to actually prevent experimental work. On the other side too much reliance has apparently been placed upon automobile production methods. It would be fatal to consume a year in improving a proven foreign airplane, although that is the time usually necessary to bring out a new automobile model. There is sufficient talent and creative genius among American aeronautical engineers trained in American production methods to not only copy or adapt foreign machines but to produce all-American training, fighting or bombing machines for use with the Liberty and other proven American and foreign engines, if full opportunity is given them.

The manufacturers welcome the most severe Government inspection; in fact they insist upon it. They should be permitted, however, to substitute materials of equivalent quality if specifications cannot be lived up to without involving delays.

The constant flow of reliable information from responsible officials to the manufacturers is essential. Under present conditions the manufacturer is usually given a tentative order for a machine which is understood to be ready for production. He must prepare his plant, build up his force and place his orders for material. It has been the rule rather than the exception for serious loss of time to result before official information or data is available upon which the work can be actually started. It may be that a model machine is not available or specifications or bills of material are held up. The result is obvious.

It has been impossible for manufacturers to estimate at all as to the probable outcome of their work from a financial standpoint. This has been due to the acceptance of a type of machine today and its abandonment immediately afterwards, or to changes in design which involve the entire disruption of schedules. It has been a common experience for delay in receipt of essential accessories ordered direct by the Government to hold up the delivery of machines for weeks.

When an order is placed, the manufacturer should be immediately given all available information in regard to the machine in question. He should be permitted to go ahead under his own methods and produce the first machine. At the same time production drawings, specifications and bills of material are keeping pace with the actual construction of the first machine. With the acceptance of the first machine and a definite schedule laid out for its production, no changes should be permitted until the completion of the number agreed upon in advance. A clause in some of the contracts is intended to safeguard the manufacturer from the necessity of making changes prior to completion of a specific number of machines. But in practice this has not worked out. Notification of change comes to the production department with definite instructions to withhold fabrication of the various parts. Despite the contract clause it has been found necessary to suspend production, and even though the parts were produced according to the contract arrangement the Accounting Section of the Signal

News of the Fortnight

Progress of Postal Air Plans

According to official announcements made by the Post Office Department the question of obtaining satisfactory landing stations for the proposed aerial mail route between Washington, Philadelphia and New York, has been definitely solved.

The Washington terminal will be located on the polo grounds in Potomac Park, while the New York terminal will be situated at Belmont Park, L. I. The latter place, which has had a glorious history in the annals of American aviation, has been tendered to the Post Office Department free of any charge by its owners, the Westchester Racing Association.

The postal aerodrome of Philadelphia will be situated at Bustleton, North Philadelphia; this site comprises a tract of 130 acres, and is regarded as very advantageous. Being located at a distance from tall buildings, landing and starting will be facilitated, while it is convenient to the railroad depot at North Philadelphia and within twenty-five minutes' run by motor truck to the main post office.

With arrangements at Washington, Philadelphia and New York perfected, and the planes and aviators ready at the call of the Department, all that seems to stand in the way at present is the completion of the postal aerodromes. Hangars and other improvements are now in course of construction at all the three fields and it is confidently expected to inaugurate the service on May 15, the date last named.

Meanwhile two bills bearing on this service are pending in the Senate. One (S. 4208) was introduced by Senator Sheppard on March 28 and permits the Postmaster General, in his discretion, to require the payment of postage on mail carried by airplane at not exceeding 24 cents per ounce, or fraction of an ounce.

The other (H. R. 9414), which is known as the Post Office Omnibus bill, was passed by the House on March 26. In addition to a similar provision as to airplane postage contained in the Senate bill, it makes the following provision:

"That the Secretary of War may, in his discretion, deliver and turn over to the Postmaster General from time to time, and without charge therefor, for use in the Postal Service, such airplanes and automobiles or parts thereof as may prove to be, or shall become, unsuitable or unnecessary for the purposes of the War Department; and the Postmaster General is hereby authorized to use the same, in his discretion, in the transportation of the mails and to pay the necessary expenses thereof out of the appropriation for inland transportation by steamboat or other power boat or by airplanes or star route."

Both bills are now in the Committee on Post Offices and Post Roads.

The 1918-19 Postal Appropriation

Senator Bankhead on April 2 reported out from the Committee on Post Offices and Post Roads the bill (H. R. 7237) making appropriations for the Post Office Department for the fiscal year ending June 30, 1919.

This bill carries a total appropriation of $331,316,070, which is a decrease from $333,726,045 in the bill as passed by the House last December, which in turn was a decrease from $335,088,345, representing the estimates by the Department.

The feature of chief interest to AVIATION AND AERONAUTICAL ENGINEERING readers is the appropriation, as made by the House, of "not exceeding $100,000 for the purchase, operation and maintenance of airplanes for an experimental airplane mail service between such points as the Postmaster General may determine."

There also is a provision, which is one of the Senate Committee's amendments to the bill, authorizing the Postmaster General to fix the postage of airplane mail at not exceeding 24 cents an ounce or fraction thereof.

Another amendment made by the Senate Committee provides for the delivery to the department by the War Department of airplanes, etc., for this service.

Provision for both of the latter items has been made in the separate bills above reported which passed the House last month. The text of all the bills is virtually the same.

H. W. Johns-Manville Moves

The Youngstown, Ohio, office of the H. W. Johns-Manville Co. will be located at 520 Market Street after April 1.

New Insignia for American Aircraft

A new national insignia for all United States Government aircraft has just been adopted. This insignia is a red circle, circumscribed about inner blue circle and center white circle. The diameter of the red circle will be five feet for all airplanes having a chord length equal to or greater than five feet. In case the chord length is less than five feet the diameter of circumscribed red circle will be made equal to such chord length. The diameter of the inner blue circle will be two-thirds and the diameter of the center white circle will be one-third of the diameter of the red, circumscribed circle. The shades of red, white and blue will be the same as those used in the American flag.

One of each of these insignia will be placed on the upper surface of each upper wing in such a position that the circumference of the circumscribed circle just misses contact with the wing flap. One of each of these insignia will be placed in a corresponding position on the lower surface of each lower wing. Both sides of that portion of the rudder which is in rear of the rudder post will be painted with three equally wide bands parallel to the vertical axis of the airplane and colored red, white and blue, the red band being nearest the rudder post, the white band in the center, and the blue band at the tail of the rudder.

One of these insignia will be placed on top and one on bottom of envelope of each dirigible balloon, the center of each insignia being in a vertical plane through the longitudinal axis of the envelope. The center of the insignia on top will be at the intersection of the vertical plane with a vertical plane through the point of greatest diameter of the envelope. The center of insignia on botton will be just forward of suspension band. The circumscribed circle of the insignia for a dirigible will be 5 ft. in diameter.

The rudder of each dirigible will be marked in a manner similar to that applied to airplanes, except that stripes will not exceed 5 ft. in length or 18 in. in width. If there is more than one rudder, only the outboard side of each outboard rudder will be marked.

One of these insignia will be placed on top and one on the bottom of envelope of each captive balloon, the center of each insignia being at the intersection of a vertical plane through the longitudinal axis with a vertical plane through the greatest diameter of the envelope. The red circumscribed circle will be five feet in diameter.

For U. S. Navy free balloons there will be two distinguishing insignia five feet in diameter to be placed on the envelope, one at each end of a diameter which is inclined 45 deg. to the vertical axis of the balloon.

The designating number of each airplane and dirigible will be placed in figures 3 in. high on each side of the rudder, at the top of the white band before mentioned.

The designating number both in the case of free balloons and captive balloons will be placed on the envelope just below, or just abaft, the lower distinguishing insignia, the letter and figures to be black, three inches high and three inches below insignia. In case the color of the envelope is such that black figures are not readily distinguishable, there will be a white background with one inch margin about the designating number.

All naval aircraft will be immediately marked in accordance with the above requirements, and in future, specifications for naval aircraft will require that the contractors place the building number and distinguishing insignia on all aircraft, and on such spare parts as bear these marks in completed aircraft.

The above markings were adopted by the Joint Army and Navy Technical Aircraft Board on Jan. 11, and have received the approval of the Secretary of War and the Secretary of the Navy.

Four Hundred Photographers Wanted

A call for 400 photographers for the Photographic Section of the Air Division, Signal Corps, U. S. A., was made at Washington last week by the Provost Marshal General. The call was issued to the Adjutant Generals of several states and gives the place and date of mobilization as Madison Barracks, Sackett's Harbor, N. Y., on April 15.

Sturtevant Co. Expands

At a time when, according to newspaper accounts, the aircraft program is literally shot to pieces, due to failures, delays and changes, it is a pleasure to be able to record that the Sturtevant Airplane Co. of Jamaica Plain, Boston, is reported, on reliable authority, to be considerably ahead of its schedule for wings, tail assembly and other parts.

The company is now erecting a new two-story building which will add 30,000 odd sq. ft. to its space. New offices are also being occupied to take care of a large office organization. The force of the company has been expanded over six times in number since Nov. 1, 1917. By July 1 it is expected that it again will have doubled.

The Sturtevant Co. is probably the only airplane company which is operating under canvas. Having outgrown its present factory, the company erected a large circus tent, under which various saws and other machine tools are running full blast. The ground is covered with sawdust, and every child in the neighborhood is anxiously awaiting the arrival of the elephants and the pink lemonade.

No Licenses for Civilian Flying

The Joint Army and Navy Board on Aeronautic Cognizance made a ruling last week that no licenses whatsoever will be issued for civilian flying.

This board was appointed under the proclamation made by the President on March 4, requiring licenses to be obtained by any person who contemplates flying in a balloon, airplane, seaplane, or other aircraft after thirty days from the date of the proclamation, except aircraft operated by the Army or Navy.

On account of some of its first members having been detailed at different points because of the exigencies of war, it has become necessary to reorganize the Joint Army and Navy Board on Aeronautic Cognizance and the reorganization was effected late last week.

The membership of the reorganized board is composed of three representatives each of the Army and Navy, respectively, and is as follows: Maj.-Gen. George O. Squier, Chief Signal Officer; Col. H. H. Arnold and Lieut.-Col. C. E. Brigham, of the Signal Corps, representing the U. S. Army, and Capts. N. E. Irwin, J. R. Y. Blakeley and F. H. Clark, representing the U. S. Navy. General Squier is chairman.

Dayton-Wright Growing

One of the greatest difficulties with which airplane manufacturers have had to contend was securing an adequate supply of qualified skilled labor. The furniture, cabinet and metal working industries have been heavily drawn on for this purpose. The training of these men to the highly specialized work of airplane construction has been one of the deterrents to maximum production during the first months. A great improvement in this condition recently will have its effect.

To build up a force of over 3000 such as is now employed at the Dayton-Wright Airplane Co. of Dayton, O., has taken the best part of a year.

Plant No. 1, or the main plant located at Moraine City, has 2200 people on the payroll. Plant No. 2, located at Miamisburg, has more than 400, and Plant No. 3, located at Third and Coleman Streets, has 300. The Experimental Station, at South Field, has a few more than 100. In round numbers, there are 3000 people employed at the different plants. This number is being increased very rapidly. Recently, in four days, 600 people were added to the force. When operating to its capacity it is expected to have 7000 employes.

Liberty Loan Advertising

The publication of 16 pages of Liberty Loan advertising in this issue has been made possible by the patriotic cooperation of the following companies: Acieral Co. of America. Barcalo Mfg. Co., The Fafnir Bearing Co., L. W. Ferdinand & Co., The Fox Machine Co., Wm. Harland & Son, Walker M. Levett Co., Lanzius Aircraft Co., Grover C. Loening, Sperry Gyroscope Co., Splitdorf Electrical Co., Standard Aircraft Corp., Strauss & Buegeleisen, Thomas-Morse Aircraft Corp., Wright-Martin Aircraft Corp., Wyman-Gordon Co.

Air Service Needs Watchmakers

Fifty expert watchmakers are needed for immediate service in France in the air service repair department, according to a call sent out March 23 by Commander Grady, inspector of the Eastern Department of the Navy. First class ratings will be given men accepted for service.

Official Test of Resistal Goggles

Discussion over the relative merits of glass used in non-shatterable goggles has been ended by the official report just issued by Director S. W. Stratton of the Bureau of Standards, Department of Commerce, after tests made at the request of the National Advisory Committee for Aeronautics.

Two types of protected glass were tested—type A, one side of which is covered with a layer of celluloid, and type B, in which is welded a layer of celluloid between two layers of glass.

The object is to prevent splinters of the glass when broken from entering the eyes. Type B is the glass used in Resistal goggles, the superiority of which is attested by Director Stratton's report.

One test was made by firing bullets into the glasses from a distance of twenty-five yards. Type A glasses received a ragged hole and were badly shattered, although the celluloid film continued to hold most of the pieces of glass together. Bullets passing through type B glasses made a clean cut hole and produced cracks in each of the discs separated by the celluloid, the cracks being confined to a circular area of about two inches. All the glass except a small area around the bullet hole was firmly held by the celluloid. Ordinary plate glass when struck by a bullet flew into pieces.

The report concludes with the following strong endorsement of the type of glass used in Resistal glasses (type B):

"The relatively increased non-shatterability of laminated glass and its comparatively good transparency and rigidity even after puncture, give it great importance in devices for protecting the eyes and face."

Changes in the Liberty Engine

In the New York *World* of April 4, Frederick Upham Adams tells of investigations that he has made on the cause of delay in the production of the Liberty engine. He charges that for over six months there has been no cessation in the stream of changes in design that have been ordered. He says: "Only an official investigation can determine the actual number of constructional changes that have been ordered. There is overwhelming evidence that these changes are far in excess of 500; I examined proof that seems to indicate that these changes number more than 1000, and a competent authority informed me that the total exceeds 2000."

While the number sounds large, it must be remembered that it is usually estimated that it takes two or three years to perfect the design of an aeronautic engine, and when it is considered that announcement has been made that no more changes in design will now be made, it is assumed that the present model will be placed into fast production. It can further be said that any delay on the Liberty engine to date has not retarded the production of airplanes, for it is generally believed that the production of engines has exceeded that of the aircraft for which they were to be used.

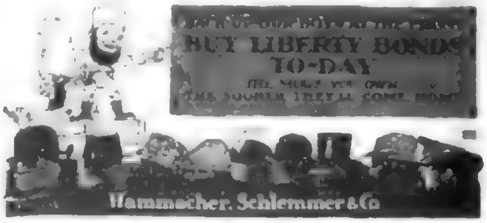
New Model Aero Club

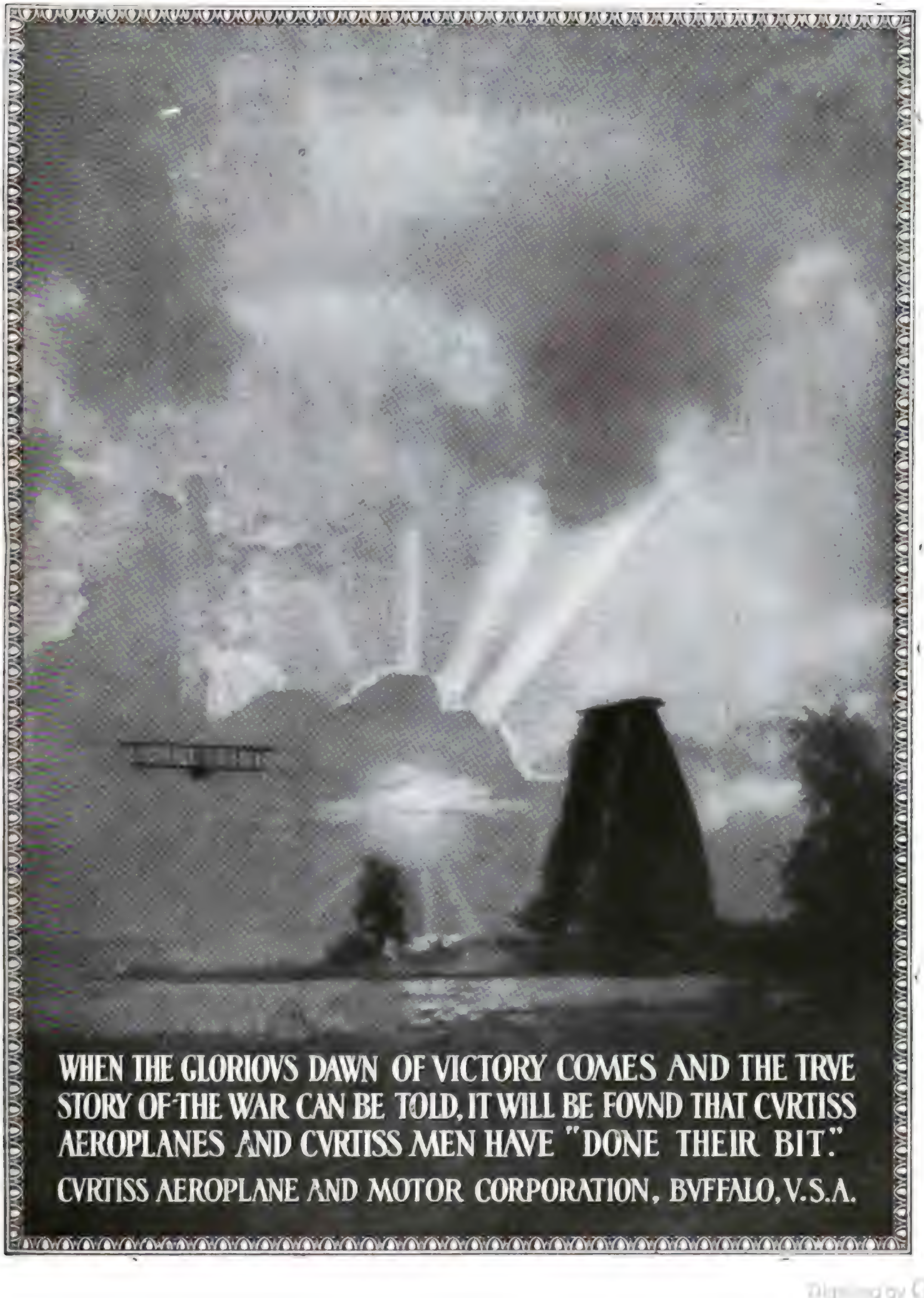
A branch of the Model Aero Correspondence Club was established in Washington, D. C., on or about Feb. 15, and is Chapter 2 of the parent organization, which is located at Babylon, L. I., N. Y., and of which Thomas Stanton is president and Edwin A. Jenkins, corresponding secretary.

The Washington Chapter has quarters at 3122 Thirty-eighth street, N. W., and the officers are: Daniel C. Long, director, and Luke C. Okna, secretary.

Attractive Liberty Loan Poster

Hammacher, Schlemmer & Co., New York, dealers in hardware, tools and supplies, have prepared a poster advertising the new Liberty Loan. It is an attractive two-color, orange-and-black card, 11 by 21 in., and is to be placed in about 1350 street cars in and about New York.




WHEN THE GLORIOVS DAWN OF VICTORY COMES AND THE TRVE
STORY OF THE WAR CAN BE TOLD, IT WILL BE FOVND THAT CVRTISS
AEROPLANES AND CVRTISS MEN HAVE "DONE THEIR BIT."
CVRTISS AEROPLANE AND MOTOR CORPORATION, BVFFALO, V.S.A.

Why Buy Liberty Bonds?

WHY do you save to build a home? It is usually cheaper to pay rent. Why do you plan to give your children a good education? Will you get any money-dividends from that?

Why do you pay fire insurance premiums and life insurance premiums? You personally will get little if anything from that.

Why do you call the doctor quickly if the children are ailing? You don't stop to think whether you can afford it. Do you?

None of these expenditures are what we call good investments. They don't pay in money, yet all pay the finest of dividends.

Liberty Bonds represent the home, the school, the children; they represent all the great deeds of our fathers and grandfathers; they represent Bunker Hill and Yorktown and Gettysburg: they represent the blessed freedom under which we all live and they also represent the ORDER that makes freedom blessed.

They represent the boys "over there"; they represent devastated Belgium and homeless Serbia and murdered Armenia.

They are the defense that shall keep from our shores the monster criminals who outraged the women of Belgium and Northern France and made the men slaves;

They represent the strength that shall restore Belgium and rebuild France and avenge Serbia;

They are the voice of those who are too young or too old or too weak to fight: they are the sword of the women and the cannon of the children; they are the voice of a free people calling to cruelly wronged, freedom-loving men and bringing them succor.

Buy them? Of course you will buy them. You'll borrow to buy them.

You don't need to be urged. You would be ashamed to go home to your children if you did not buy them.

The rate of interest is important but not of first importance. They would pay, they would appeal to you, if they bore no interest whatever.

Add to the rate of interest the dividends they pay in self-interest, in safety, in public order, in liberty and law and you have a larger return than you receive from any other thing you own.

They will never become "scraps of paper."

They are the best secured investment in the world.

You Stand Behind Them

You Should Buy Them

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120 BROADWAY, NEW YORK CITY

Gillette

Safety Razor

Have You Seen the New Gillettes Specially Designed for the Fighting Man?

THESE models were designed by members of the Gillette Organization who have seen service with the Colors and know what the soldier is up against.

Hundreds of officers and men are buying them — the U. S. Service Set in metal case, and the new Khaki-covered sets for Uncle Sam's soldiers and officers.

The Gillette is the one razor for the man who is doing things — the one razor with world-wide use and reputation.

When a man wants new Blades he can get them at any Post Exchange or Y. M. C. A. Hut — here in America or Overseas.

Our Paris Office carries stocks — is constantly supplying the American Expeditionary Forces. Gillette Safety Razors and Blades on sale everywhere in France, England, Italy and Eastern battle fronts.

Why the Gillette Is Especially the Soldier's Razor

THERE isn't a harder shaving job on earth than the service demanded of the Gillette by the fighting man.

Under the very worst possible conditions of climate — with cold or hard water — on sun-burned or wind-chapped faces — the Gillette is called upon for its solid-comfort, velvet-smooth shave. *And delivers it.*

There are more Gillettes used than all other kinds of razors added together — the compact, complete razor with no strops or hones to clutter up the kit.

Hundreds of thousands of officers and men have adopted the Gillette — with its blades always sharp, always ready. No Stropping, No Honing.

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Gillette Safety Razor Societe Anonyme
17 Bis, Rue La Boetie, Paris, France

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53 Liteiny, Petrograd, Russia

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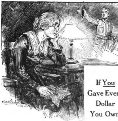
Via Senato, 18, Milan, Italy



If You Gave Every Dollar You Own

how little would the sacrifice be compared to theirs.

We are not asked to give. We are asked only to *lend*. To lend at good interest secured by the best collateral on earth

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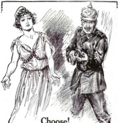

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Invest now to the limit of your ability in

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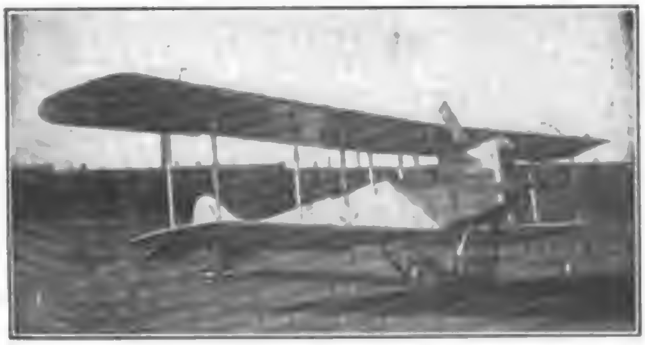
The Continental Aircraft Corporation

Factory and Aviation Field
AMITYVILLE, L. I.

New York Office
120 LIBERTY STREET

MANUFACTURERS OF

Airplanes, Experimental Airplanes and Parts



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Their

SIMPLICITY
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make them the logical equipment for the Modern Airplane.

Weight 96 pounds complete with tires built for craft weighing 2500 pounds

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Designed by experts. Material of the highest grade, rigidly inspected, used in their construction. Experienced workmen, with a thorough knowledge of their craft, build them. Production carried on in the largest and most efficiently equipt Aero Propeller factory in America.

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It illuminates the figures and hands of his buoyancy meter and other instruments so that they stand out as clearly and distinctly as by day.

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Our service is designed for the convenience and the greater economy of manufacturers of indicating instruments.

We apply Luma to dials of every description.

Our work insures the greatest attractiveness and maximum results.

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Felt value is determined by wool, hardness, resiliency, density, etc. Are you sure that the FELT now used for your parts is exactly suited to the purpose? Our Special Service Engineers will tell you—without obligation. Consultation is FREE.

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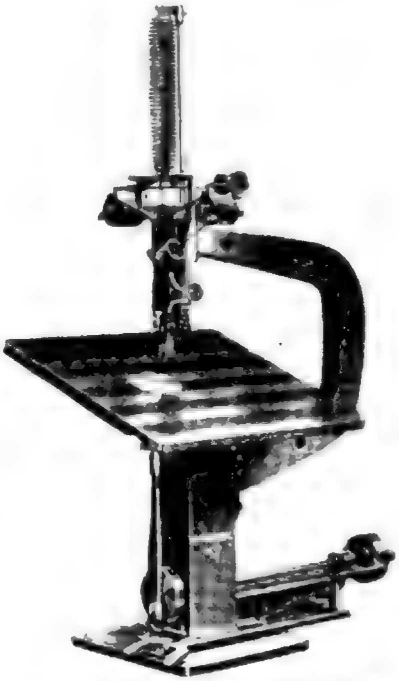

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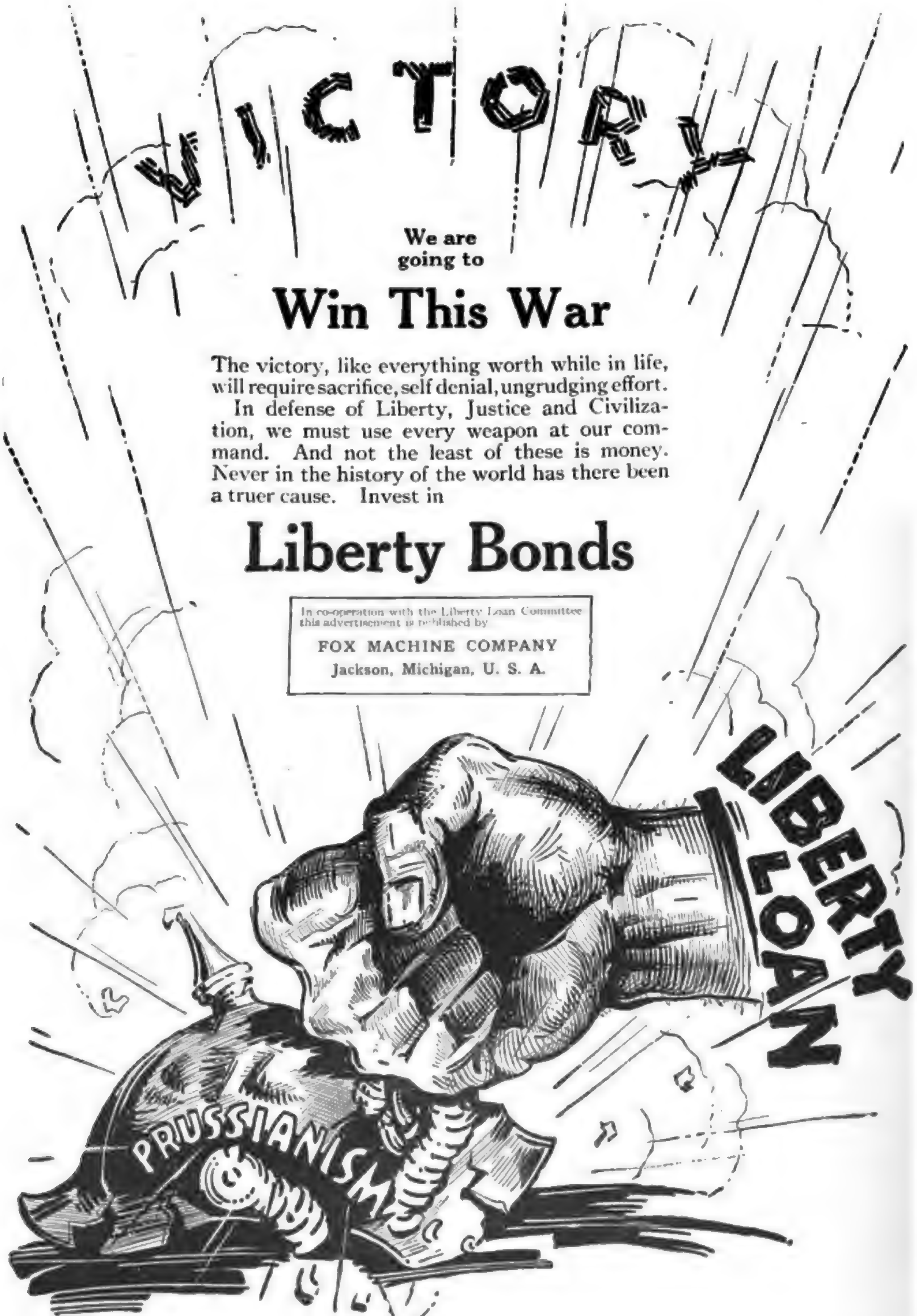

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State of New York }
County of New York } ss.

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared George Newbold, who, having been duly sworn according to law, deposes and says that he is the Business Manager of AVIATION AND AERONAUTICAL ENGINEERING and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

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2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

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3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

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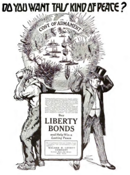
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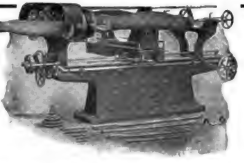

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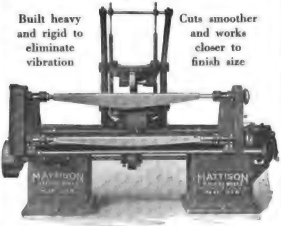

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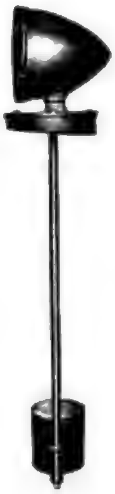

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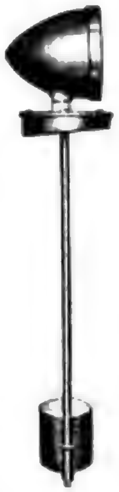

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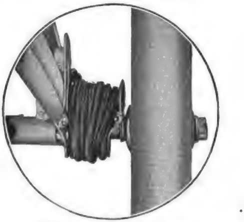

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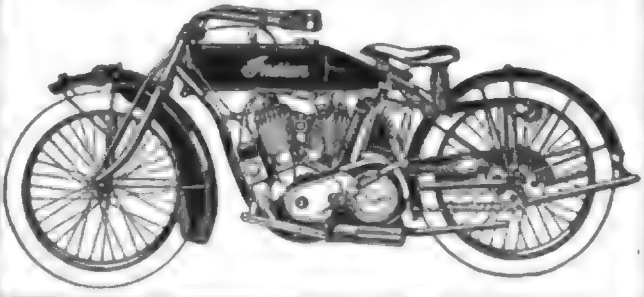

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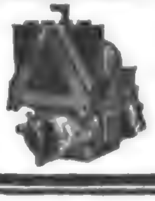

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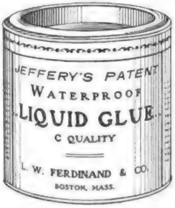

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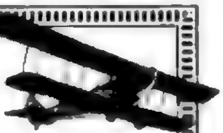
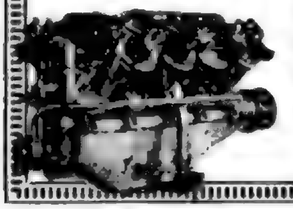

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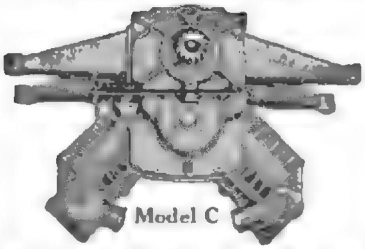

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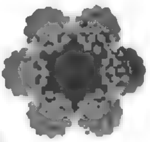

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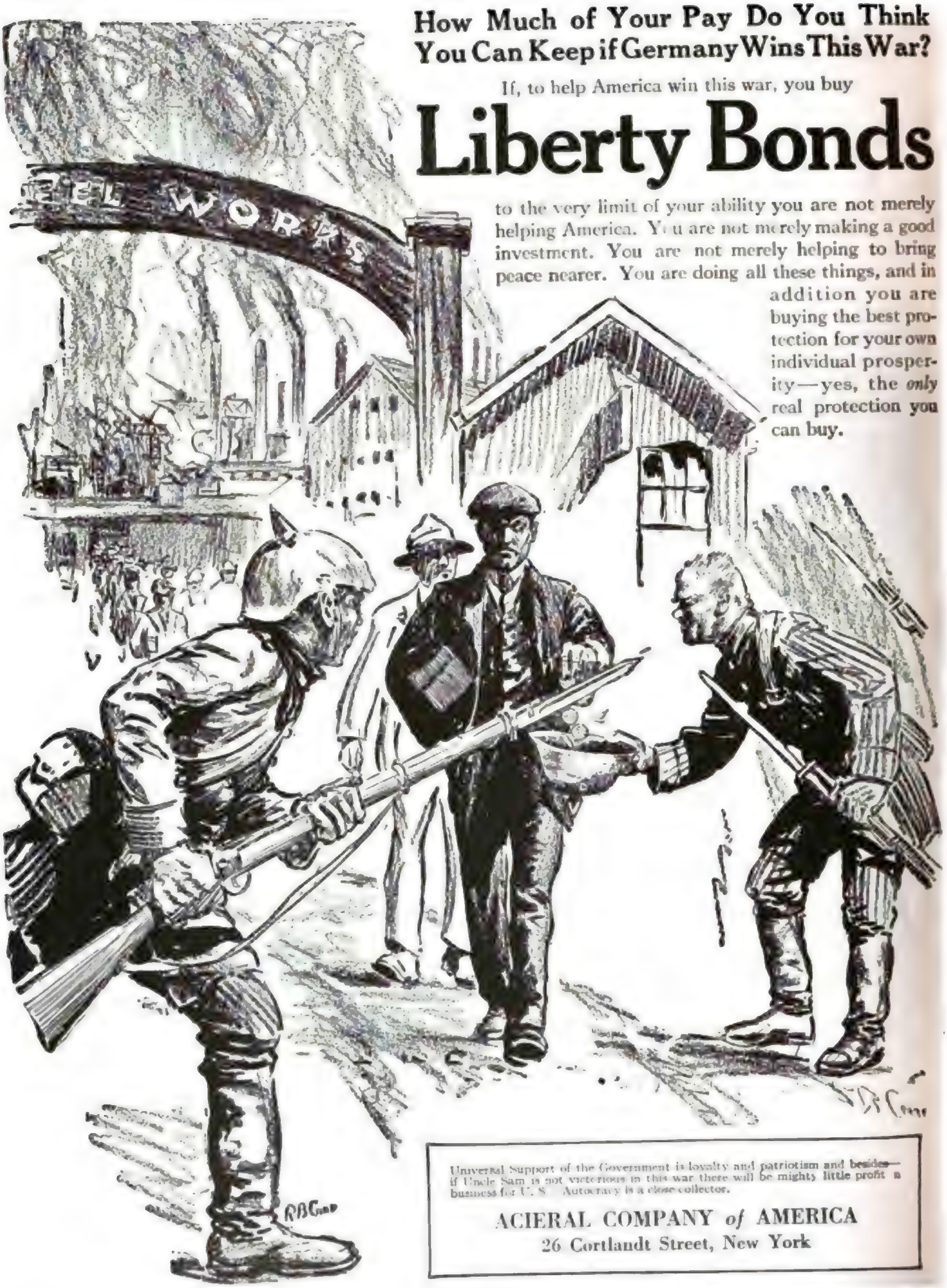

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AVIATION
AND
AERONAUTICAL ENGINEERING

Photo Press Illustrating Service Midwing View of a Caproni Biplane

VOLUME IV
Number 7

PRICE
Fifteen
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SPECIAL FEATURES
REORGANIZATION OF THE ARMY AIR SERVICE
THE EFFECT OF AN AIRPLANE RUDDER IN FLIGHT
THE EVOLUTION OF THE AIRPLANE
THE GALLAUDET AIRSCREW PROPULSION DESCRIBED
THE MODEL C.V ALBATROS BIPLANE

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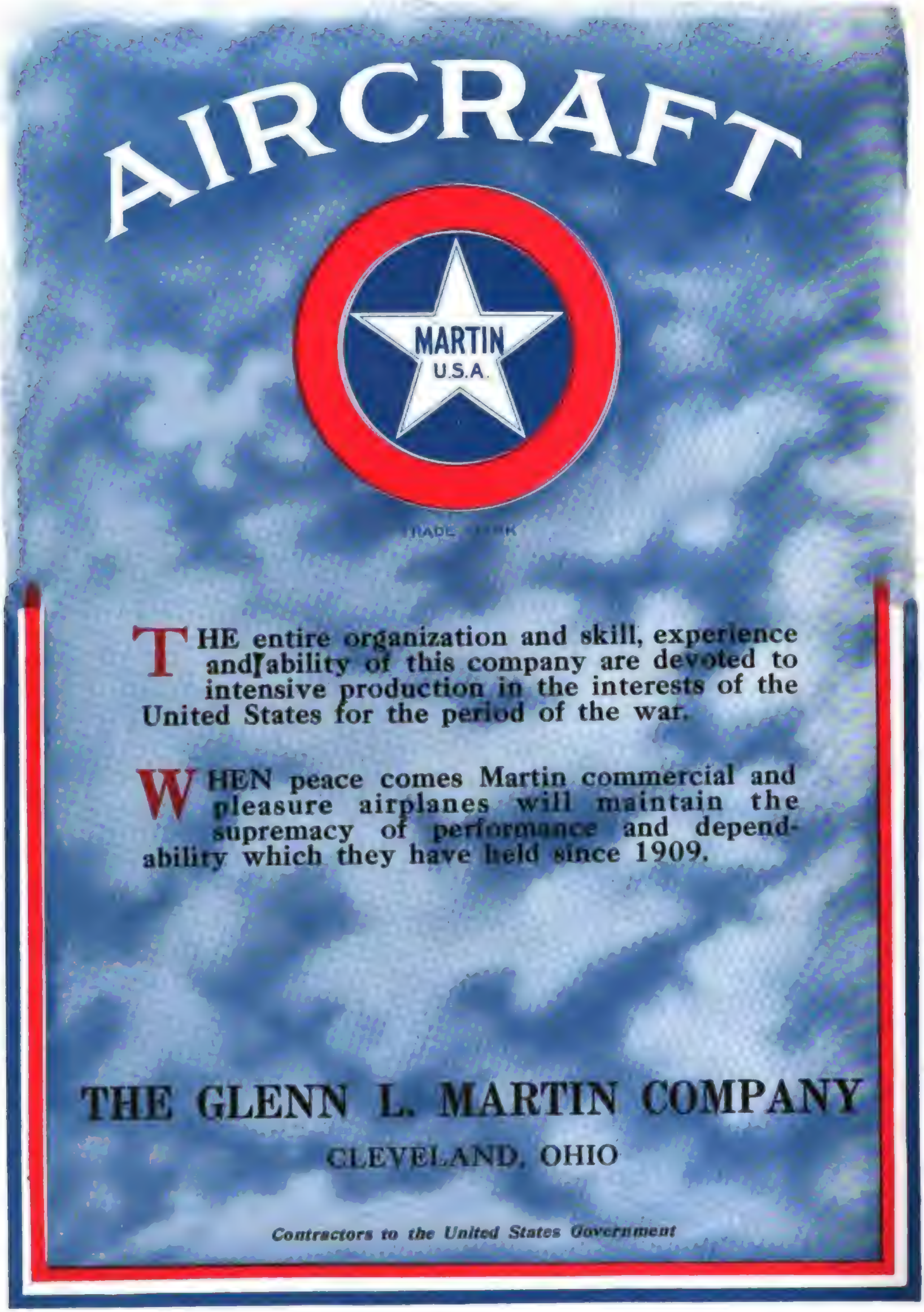

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VOL. IV. NO. 7

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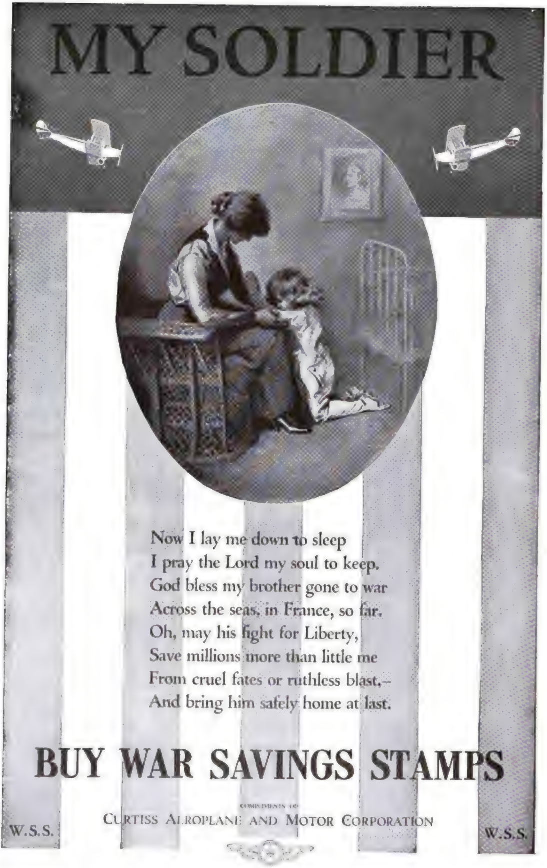

MY SOLDIER

Now I lay me down to sleep
I pray the Lord my soul to keep.
God bless my brother gone to war
Across the seas, in France, so far.
Oh, may his fight for Liberty,
Save millions more than little me
From cruel fates or ruthless blast,–
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Vol. IV May 1, 1918 No. 7

Reorganization of the Army Air Service

Henceforth John D. Ryan of Montana and New York will direct the production of aircraft for the United States Army, and will serve as chairman of the Aircraft Board. Mr. Ryan was called to Washington on Tuesday, April 23, and notified that he had been selected. After a conference on Wednesday in the office of Secretary of War Baker, in which Assistant Secretary of War Benedict Crowell, Second Assistant Secretary of War Edward R. Stettinius, Maj.-Gen. Peyton C. March, Chief of Staff and Mr. Ryan participated, the announcement was made of Mr. Ryan's acceptance.

William Chapman Potter will continue in charge of the actual production work as Chief of the Equipment Division.

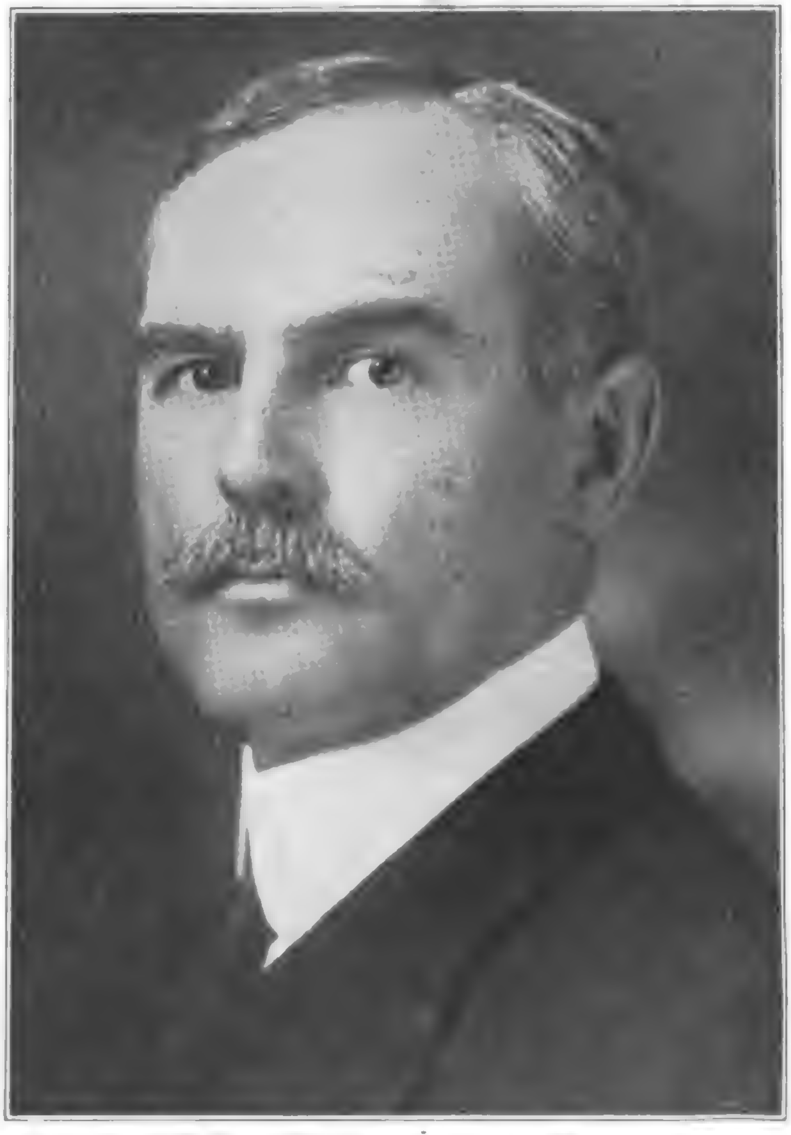
A "Division of Military Aeronautics" according to Secretary Baker's announcement will be created under command of Brig.-Gen. William L. Kenly, N. A., who recently returned from France, where he familiarized himself with aircraft conditions and needs. This "division" will have control of the training of aviators and direct the military use of aircraft. It will be an organization entirely separated from the Signal Corps. This Division of Military Aeronautics will have a new insignia that will differ from the present Signal Corps insignia.

It is apparent that many officers in the Air Service are heartily in favor of the separation of that branch from the Signal Corps.

It is understood that Gen. Kenly favors the administration of the Army, Navy and Marine Corps flying organizations as a separate body, similar to that of the British. It is also thought that Mr. Ryan's appointment as Chairman of the Aircraft Board means that Secretary Daniels will delegate to him the direction of production for the Navy as well. In influential quarters it is not believed that a new cabinet office need be created to carry out these changes. At this writing no details of the reorganization have been communicated to the interested officers.

During a call on Mr. Ryan in Washington a representative of Aviation and Aeronautical Engineering gained the impression that the new policy will embrace *a square deal for aircraft manufacturers, an open channel for information and the quickest possible decisions.* Mr. Ryan and Mr. Potter are social as well as business friends, and it is believed that the suggestion of Mr. Ryan's name for this vitally important work came from Mr. Potter.

Maj.-Gen. George O. Squier will continue as the administrative head of the Signal Corps.



John D. Ryan, Director of Aircraft Production
Central News Photo Service

Official Announcement

The official announcement reads:

"Mr. John D. Ryan has accepted the directorship of aircraft production for the army.

"A reorganization of the Aviation Section of the Signal Corps has been also effective, of which the principal elements are as follows:

"General Squier, as chief signal officer, will devote his attention to the administration of signals; a Division of Military Aeronautics is created, under the direction of Brig.-Gen. William L. Kenly; the Aircraft Board, created by act of Congress, remains an advisory body as it has been in the past, with Mr. Ryan as its Chairman. This arrangement is made with the entire concurrence of Howard C. Coffin, who remains a member of the Advisory Commission of the Council of National Defense, and will render assistance and counsel to the Aircraft Board and Mr. Ryan.

"The Division of Military Aeronautics will have control of the training of aviators and the military use of aircraft. *The exact division of function in the matter of designing and engineering will be worked out as experience determines between the Division of Military Aeronautics and the Division of Production.*

"This announcement involves no change of personnel in the present equipment division of the Signal Corps, of which W. C. Potter is Chief, and which will continue under his direction."

To give Mr. Ryan authority to exercise the duties of Chairman of the Aircraft Board it will be necessary for President Wilson to nominate him to the Senate for that office, and his appointment must be sanctioned by that body.

According to Washington reports there are to be virtually three engineering bureaus. One will produce present designs without any more delay; another will improve these designs, while the third will be ready to place itself at the disposal of inventors.

Mr. Coffin's Statement

The Aircraft Board will remain as an advisory body, Mr. Ryan taking the chairmanship. Howard C. Coffin will withdraw from the Board. He approves the appointment of Mr. Ryan and says:

William Chapman Potter, Chief of Equipment Division
Photo Campbell Studio

"The appointment of a single individual with definite and adequate power to deal with all aspects of army aircraft production is a logical and necessary step. It is necessary to get away from any question of a division of responsibility, either in fact or in the public mind. The Aircraft Board remains as since its creation in October, an advisory body, but under this new arrangement the chairman of the board becomes also the supreme executive agency. For proper results both the power of execution and the responsibility must be concentrated in the same hands. The method of Mr. Ryan's appointment would seem to accomplish this result."

Mr. Ryan's Career

Mr. Ryan's first service to the Government in the present crisis was when several million pounds of copper were required and the market price was 30 cents a pound. Acting with Daniel Guggenheim, Mr. Ryan supplied the quantity needed at 16 2/3 cents a pound. Since last July he has been director general of military relief for the American Red Cross Society, but will relinquish that work to apply himself wholly to his new assignment.

In importance and fitness Mr. Ryan's appointment is viewed as paralleling the selection of Charles M. Schwab to direct the Emergency Fleet Corporation. Mr. Ryan is regarded as a man who knows how to handle a great business undertaking in a large way. Born at Hancock, Mich., Oct. 10, 1864, he comes from a mining family. His father was the discoverer of what are now known as the Copper Range Mines of the Lake Superior district. Shortly after his birth the family moved to the Calumet and Hecla mine. His parents wanted him to enter college, but he preferred to go to work and started in the employment of an uncle who owned a chain of general merchandise stores in the copper district.

When he reached the age of 25 he went to Denver. Illness had forced a brother and a sister to move to the Colorado city and he joined them. For six months he was unable to find employment—"and I wasn't particular about what I did, either," he remarks. Finally he found a job as a drummer selling lubricating oil for a concern which was fighting the Standard Oil Co. He travelled the Rocky Mountain section from Montana to Mexico. It was at this time that he first met Marcus Daly, the great Montana copper magnate, who became his very good friend, although he never did a day's work in his life for Mr. Daly. At this time his earnings varied from $100 to $150 a month.

His Conquest of Montana

When Mr. Daly died Mr. Ryan used his savings and borrowed freely to acquire an interest in the Montana chain of banks established by Mr. Daly. He soon became the managing director of these institutions and so successful did they become that they attracted attention throughout the country. Among others who were watching Mr. Ryan's progress was Henry H. Rogers, the Standard Oil Company's genius and head of the Amalgamated Copper Co. At that time conditions in Montana were chaotic, industrially and politically, and the Amalgamated Company was in the middle of the fray, fighting almost for its existence against Fritz Augustus Heinze. The entire state was split between the Amalgamated Company and Heinze. Labor was in a turmoil, naturally. Money was spent without stint. Loss of a human life now and then was of no moment. Politicians were drawn to one side or the other by the "gambling route," i. e., they were permitted to win.

The fair sex, too, played its part in the battle. This state of affairs went on for three years and then in 1904 Mr. Rogers turned to Mr. Ryan for help in clarifying the situation. Mr. Ryan became managing director of the Amalgamated Copper Co. with entire charge of mines and employes in Montana. At the very first election Heinze was soundly beaten, and, after vainly struggling for two years more, sold his interests to the Amalgamated Company.

The transformation in Montana was remarkable. In a state torn by bitter feuds, personal acrimony and corruption, Mr. Ryan developed order, respect for the law and prosperity. Not once during Mr. Ryan's management did the Amalgamated Company lose a day from labor troubles.

In the hour of his triumph Mr. Ryan might have made things very unpleasant for his adversaries; but that was not his policy. Instead he treated friend and foe with scrupulous fairness and soon won the confidence of all factions—and that is one of the reasons why he is sometimes referred to as "The man who put Montana on the map." He is still a citizen of that state, and, although "condemned" to live most of the time in New York (and now in Washington) his heart is still in Montana.

In 1907, when Mr. Rogers' health began to fail, he induced Mr. Ryan to come to New York to look after the Amalgamated Company and when Mr. Rogers died Mr. Ryan became president of the company. In 1910 all the holdings of the Amalgamated Company and its subsidiaries were taken over by the Anaconda Copper Mining Co., and in 1914 the Amalgamated Copper Co. was dissolved, Mr. Ryan assuming leadership of the Anaconda Company.

Harnessing Water Power

Belief that Mr. Ryan can conquer air is based upon what he has done with water. After he mastered the copper situation by controlling one-sixth of the world's production he turned his attention to the hydro electric development of Montana. Today over 500 miles of railroad are operated by the water power of Montana and adjacent states and Mr. Ryan believes the electrification of railroads has barely started.

Mr. Ryan has all the breezy progressiveness and enthusiasm of the typical westerner and now combines with these qualities the financial and business experience he has acquired in the East. Not wholly opposed to publicity he will discuss most any subject he understands except himself. "You cannot write any picturesque story about me," he said recently to an interviewer. "I never did a day's mining in my life; nor was I a prodigy at school; nor have I worked harder than lots of other men."

Another thing he said will appeal to persons interested in the aircraft production situation: "Influence is the worst handicap any young man can have. It makes him feel that he need not exert himself to his full capacity and in other ways has a bad effect on him. Favoritism is a bad thing for any man or organization."

Aside from the Anaconda Company Mr. Ryan is the creator and builder of the Montana Power Co., a director in the American International, several banks and many other corporations.

At the age of 32 he married Miss Nettie Gardner of his native town and they have one son, John C. When in New York they live at 3 East 78th street and have a summer home on Long Island. Since going to Washington he has been living in a house located on the outskirts of the city, but now he will take up his residence nearer to the scene of his work.

Mr. Ryan has a faculty for handling big jobs. He is a great organizer and his business career attests his keenness. He always selects competent men to handle details and knows how to coordinate the work of those associated with him. Easily approached he at once impresses one with his personality.

An oil salesman at 35—at 54 Mr. Ryan undertakes a job upon the success of which the fate of the world may depend.

On the Job at Once

Mr. Ryan tackled his new duties for the first time Thursday, April 25. He spent the entire morning in conference with the Aircraft Board. He went over the programme and the record of what had been accomplished. This discussion was of the most general nature, as Mr. Ryan was entirely without knowledge of what had gone before. Other conferences were held in the afternoon with Signal Corps and other army officials who have had to do with aircraft production.

"I do not even know as yet," Mr. Ryan said, "where I will have my offices or headquarters. I have not even taken the matter up. For the present at least I hope to give some time to the War Council of the American Red Cross, which I have been serving. It is of course impossible for me to say anything or make any announcement until I am more familiar with the job. I expect to give it the closest possible application and justify the confidence placed in me. I will do my best."

New Legislation Needed

Mr. Ryan's position is still a little anomalous. Until the law is changed, all money spent for aircraft must pass through the hands of Gen. Squier. *The Overman bill, if passed, would permit the transfer of appropriations and functions as the President sees fit.* The law creating the Aircraft Board also stipulates that the Chief Signal Officer shall be a member. It gives the board certain definite duties. This is given as the reason why the board was retained and Mr. Ryan made its president. It is understood that part of the plan provides for legislation that would do away with the Aircraft Board and leave Mr. Ryan supreme in his field with a department of his own like the Emergency Fleet Corporation.

Mr. Ryan's first task will be to coordinate the forces producing airplanes. This is purely administrative. In the meantime Mr. Ryan is to seek to speed up every manufacturer. Production it is thought is no longer to be halted while changes are made in plans and specifications.

It is believed that no objection will be interposed in Congress to any legislation concentrating authority in Mr. Ryan.

Senate Action Awaited

On Thursday Senator Wadsworth addressed the Senate briefly on his amendment to the pending Overman bill. This would give specific authority to the President to create the office of director of aircraft production and would make him responsible only to the President. His power would be equivalent to that of a Cabinet officer.

Mr. Wadsworth explained to the Senate that under the Overman bill no right to create new agencies of government was accorded the President. He pointed out that should John D. Ryan prove, as he believed he would, the right man in this emergency he would still be subordinate to the Secretary of War and only indirectly responsible to the President. Besides being subordinate to Mr. Baker, he would also be officially the inferior of whichever of the Assistant Secretaries of War should be delegated to oversee the work of aircraft production.

Brig.-Gen. William L. Kenly, N. A.,
Commander of Division of Military Aeronautics
Press Illustrating Service

Mr. Wadsworth's proposed amendment was not debated. Senator Overman remarked that the proposal was one which possessed too much merit for the Senate to be able to ignore and asked time. Senator Kirby said that in view of the fact that the proposal was one which might be of great importance and which he himself was disposed to favor, he hoped that no immediate action would be taken.

William Chapman Potter

William Chapman Potter, who continues in charge of actual aircraft production, was born in Chicago, Oct. 16, 1874. He comes from Massachusetts colonial stock, the family having settled in Ipswich in 1635. One of his antecedents was John Potter, a lieutenant in the Revolutionary Army. His father, Edwin Augustus Potter, a former president of the Continental and Commercial Bank of Chicago, now resides at Lake Geneva, Wis.

Mr. Potter is a graduate of the Greenwood Avenue Public School of Chicago, the Chicago Manual Training School and the Massachusetts Institute of Technology in 1897. He holds the degree of M.E. and A.B.

(Continued on page 466)

The Effect of an Airplane Rudder in Flight

By Karl H. White

The object of this article is to find the moments about the center of gravity of airplanes of different lengths, caused from a rudder of different aspect ratios under varying angles of deviation; the results being shown by curves.

The following definitions should be understood before proceeding further:

The ***Aspect Ratio*** is the length of the leading edge of a surface divided by the depth, i. e., $A.\ R. = \frac{\text{Span}}{\text{Chord}}$

The ***Angle of Deviation*** is the angle which the rudder makes with the longitudinal center line of the airplane, i. e., "θ."

The accompanying sketch is the basis for all calculations.

$C.\ G.$ = Center of gravity of airplane.

O = Rudder hinge.

P = Resultant of all wind forces on rudder equal to center of pressure.

P_x and P_y = x and y components of P.

θ = Angle of deviation.

Moment Arm $_{c.g.}$ = $A + a$.

$M_{c.g.} = (A + a)\ P_y$.

In this report A = 16, 18, and 20 ft. respectively.

Area of rudder OQ = 9 sq. ft.

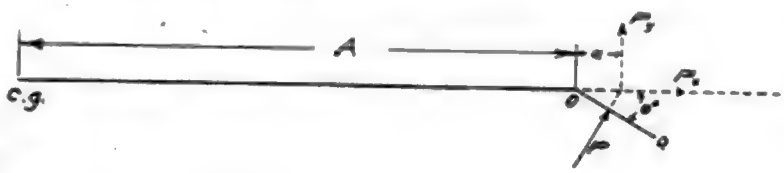
Velocity of airplane assumed to be 100 miles per hour.

Aspect Ratios of rudder = 1, 3, 6, ⅓, and ⅙ respectively.

In the following table the distances of the $C.\ P.$ (center of pressure) from the leading edge of the rudder were taken from "Eiffel's" Curves:

TABLE NO. 1

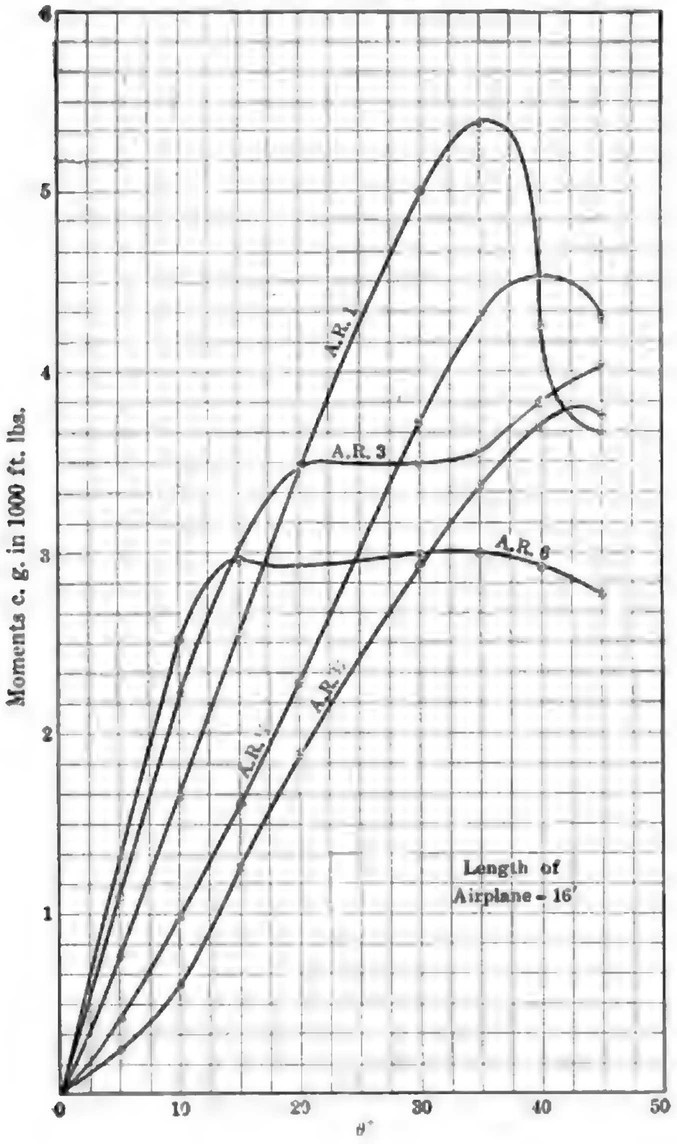
A. R.	Area of rudder = 9 sq. ft.		Distance of C. P. in percent from Leading Edge for different angles of deviation (ft.)							
	Span (ft.)	Chord (ft.)	5°	10°	15°	20°	30°	35°	40°	45°
1	3	3	.225	.26	.29	.33	39	41	.425	.43
3	5.2	1.73	24	.30	.38	.41	42	42	.425	.425
6	7.37	1.22	.28	.33	.38	.39	41	41	.42	.42
1/3	1.73	5.2	.27	.3	.31	.315	32	.325	.33	.35
1/6	1 22	7.37	.305	32	33	.335	335	335	.335	.34

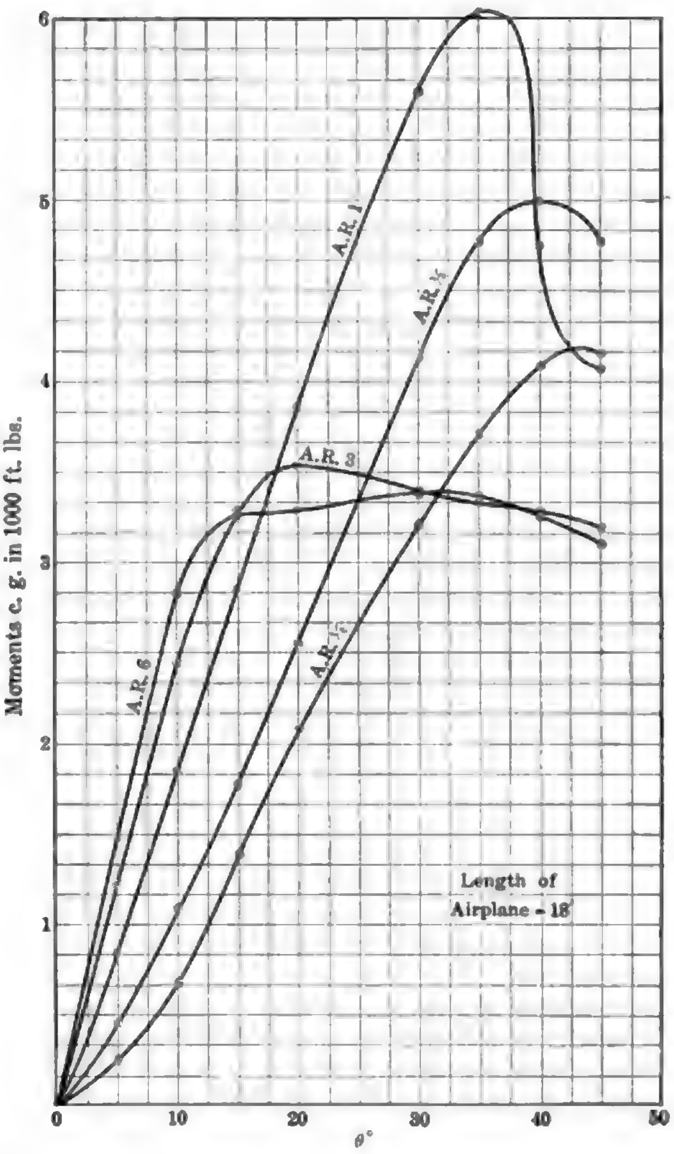


From this table when $\theta = 5°$, the $C.\ P. = .225 \times$ chord $= .225 \times 3 = .675$ ft. from leading edge.

From the sketch $\frac{.675}{a} = \cos\theta = \cos 5°$.

$$\therefore a = \frac{.675}{\cos 5°} = .677 \text{ ft.}$$



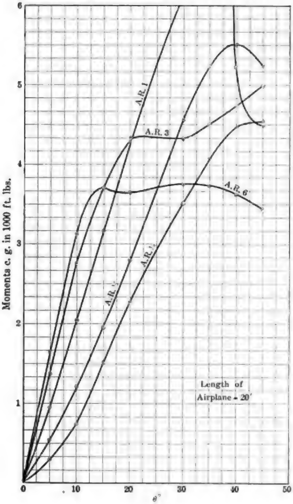


Moment Arm = 16.677 ft.
By experiment it is found that $P = K_1 S V^2$.
P = Pressure on surface.
K_1 = Value of coefficient at $i°$ angle of deviation.
S = Surface area.
V = Velocity.
$\therefore P = K_1 \times 9 \times 100^2$.
$= K_1 \times 90{,}000$.
From Eiffel's Curves $K_5° = .00051$.
$P = .00051 \times 90{,}000$.
$= 45.9$.
$P_y = 45.9 \cos 5°$.
$= 45.7$.
$M_{c.g.} = 45.7 \times 16.677$.
$= 762$ ft-lb.

The following table contains the results obtained by repeating this process, using different angles of deviation, different aspect ratios, and different lengths of airplanes:

ASPECT RATIO = 1

$i°$ or $\theta°$	a (ft.)	Value of K_1 (Eiffel)	Pressure (lb.)	P_y (lb.)	Moment = M_y (ft. lb.)		
					A = 16 ft.	A = 18 ft.	A = 20 ft
5	.677	.00051	45.9	45.7	762	854	944
10	.79	.00111	99.9	98.3	1560	1847	2042
15	.902	.00174	156.	151.	2554	2853.9	3159
20	1.05	.0024	216.	203.	3461	3867.15	4280
30	1.35	.00372	334.8	289.6	5021	5603.76	6180
35	1.5	.0042	378.	309.7	5418	6039.1	6645
40	1.645	.00351	315.0	242.	4268	4743.2	5240
45	1.83	.00324	291.6	206.1	3674	4086.96	4489



ASPECT RATIO = 3

$i°$ or $\theta°$	a (ft.)	Value of K_1 (Eiffel)	Pressure (lb.)	P_y (lb.)	Moment = M_y (ft. lb.)		
					A = 16 ft.	A = 18 ft.	A = 20 ft.
5	.417	00075	67.5	67.2	1102	1236.48	1371
10	.527	.0015	135.	135	2232	2454.9	2765
15	.682	00201	180.9	180.9	3090	3263.15	3740
20	755	00231	207.9	207.9	3474	3524.9	4320
30	839	00231	207.9	207.9	3500	3391.2	4331
35	.888	.0024	216.	216	3550	3342.3	4519
40	956	.00252	226.8	226	3832	3282.9	4740
45	1.04	.00264	237.6	237.6	4040	3192.	4980

ASPECT RATIO = 6

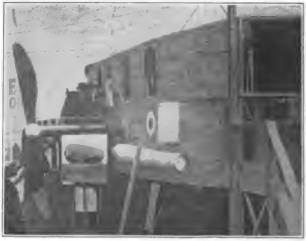
$i°$ or $\theta°$	a (ft.)	Value of K_1 (Eiffel)	Pressure (lb.)	P_y (lb.)	Moment = M_y (ft. lb.)		
					A = 16 ft.	A = 18 ft.	A = 20 ft.
5	.343	.0009	81.	80.7	1319	1480	1640
10	.409	.00174	156.6	153.8	2524	2830	3139
15	.481	.00207	186.3	180.	2965	3324	3689
20	.507	.0021	189.	177.6	2933	3288	3645
30	.577	.00234	210.6	182.	3019	3380	3742
35	.61	.00246	221.4	181.	3008	3370	3730
40	.668	.00255	229.5	175.5	2923	3272	3621
45	.725	.00261	234.9	166.	2778	3110	3439

ASPECT RATIO = 1/3

$i°$ or $\theta°$	a (ft.)	Value of K_1 (Eiffel)	Pressure (lb.)	P_y (lb.)	Moment = M_y (ft. lb.)		
					A = 16 ft	A = 18 ft.	A = 20 ft.
5	1.41	00027	24.3	24.2	422	471	519
10	1.58	00063	56.7	55.7	979	1089	1199
15	1.67	00105	94.5	91.2	1611	1790	1971
20	1.74	00153	137.7	129.1	2291	2548	2806
30	1.92	00267	240.3	208.	3730	4140	4560
35	2.06	00324	291.6	238.	4300	4760	5240
40	2.24	0036	324.	248.	4525	5010	5520
45	2.58	00366	329.4	232.2	4318	4770	5248

ASPECT RATIO = 1/6

$i°$ or $\theta°$	a (ft.)	Value of K_1 (Eiffel)	Pressure (lb.)	P_y (lb.)	Moment = M_y (ft. lb.)		
					A = 16 ft	A = 18 ft	A = 20 ft.
5	2.22	00015	13.5	13.45	245	272.1	298.8
10	2.4	000375	33.75	33.2	611	677.	744.
15	2.52	00078	70.2	67.7	1253	1389.	1521
20	2.63	0012	108.	101.5	1890	2090	2292
30	2.85	00198	178.2	154.1	2905	3220	3519
35	3.01	0024	216.	177.	3362	3720	4070
40	3.22	.00279	251.1	192.2	3691	4080	4460
45	3.54	00303	272.7	193.	3772	4160	4535



CAR OF A BRITISH RIGID AIRSHIP IN TRAFALGAR SQUARE DURING WAR LOAN WEEK

The Evolution of the Airplane[*]

By C. G. Grey

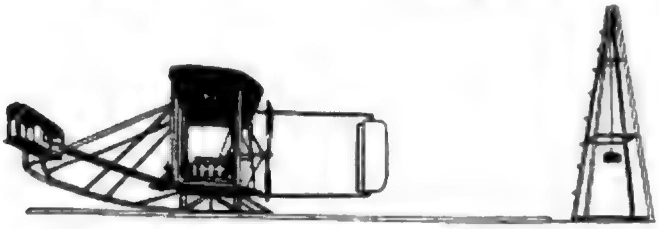
Editor of The Aeroplane

Although the first human flight on a power-driven airplane, free from control on the ground, was made by Orville Wright on December 17, 1903, it was not until 1908 that the airplane, as a more or less consistently navigable vehicle, really came into being. Consequently, in dealing with the development of the airplane that year must be taken as the starting-point.

In this article there is no attempt to give a detailed history of flying as such, but merely to indicate step by step the gradations by which the airplane of the present day has developed from the first successful machines of 1908. The airplanes illustrated herewith are those which are generally held to have initiated a fresh step in development, and to have been either the forerunner of a new type or to have been such an improvement on an existing type as to justify their claim to be considered a distinct step forward.

The Wright Biplane, 1908

The first airplane with any claim to success was, as already stated, the Wright. The 1908 type was driven by a small four-cylinder water-cooled engine, built by the Wright Brothers themselves. It was a biplane, driven by two large propellers, both actuated by chains gearing on the engine shaft, one chain being crossed—like a crossed belt on a lathe—so as to make its propeller revolve in the direction opposite to the other, and thus give proper balance to the driving force. The pilot sat alongside the engine, and slightly in front of it, and there was a seat for a passenger in between, right in the centre, so that the balance should not be altered by the added weight.



Unlike modern airplanes, this machine had no horizontal tail behind the main planes, and so it belongs properly to what is known as the "tail-first" class, called by the French the "canard"—or "duck"—class, owing to its long neck-like projection forward. The "canard" class was never successful, though tried in France by the Voisin Brothers and Blériot, and in England by H. C. Barber on the "Valkyrie." It was possible to make such machines fly, but they could never be made to steer properly. The "Valkyrie," the last of the class, died in 1913.

As the illustration shows, the Wright had vertical rudders aft, as in modern practice, and relied on the two big elevator-planes forward for its up-and-down steering. Its lateral, or rolling, movements, were controlled by warping, or twisting, the wings so that while the angle of the wings on one side was increased and gave more lift, the angle on the other side decreased and gave less lift, thus enabling the pilot to right himself—if he did not go too far over.

The pilot controlled the elevators with a lever on his left-hand side, and the warp with a lever on his right, while by waggling the jointed top of the right-hand lever he also controlled the rudder. This complicated system of control was hard to learn, and Wright pilots were few.

In 1910 the Wrights fitted a horizontal tail at right angles to their rudder, and in 1911 they dropped the front elevators altogether, but thereafter the Wright machine practically ceased to develop further, and of late years little has been heard of it.

The great peculiarity of the 1908 Wright was that it was launched by running along a rail. At one end of the rail was a pylon with a pulley at the top. A line was led over this pulley, from a heavy weight on the ground, down to the pylon end of the rail, along the rail to the outer end, over another pulley, and back along the rail to a little carriage on which the machine was mounted. When the line was pulled back to the carriage the weight was hauled to the top of the pylon. On releasing the carriage the weight fell down, hauled the carriage, and with it the airplane, along the rail, and gave the necessary speed to enable it to rise into the air. The carriage was, of course, left behind.

As airplanes developed, this catapult method of launching was discarded, and now all airplanes rise from the ground taking their own wheels with them. But for some years before the war the present writer consistently advocated that some analogous catapult method should be used for launching floatable airplanes (as distinct from seaplanes) from the decks of ships.

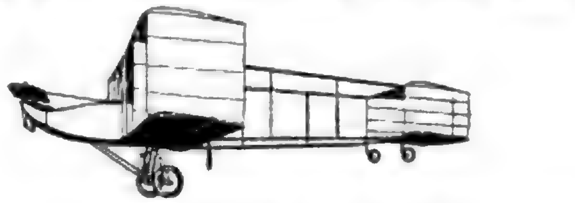
The Voisin Biplane, 1908

Almost contemporary with the Wright was the Voisin biplane. The Voisin Brothers, Charles and Gabriel, had been experimenting for some years, together with M. Blériot and Henry Farman, the experiments being assisted financially by M. Archdeacon and M. Henri Deutsch de la Meurthe. By the beginning of 1908 the Voisin biplane was flying respectably, for on March 21 Mr. Farman flew 1¼ mile at Issy, near Paris, and made a turn, and on May 30 the late Léon Delagrange flew for nearly 8 miles at an aerodrome near Rome, capping this on September 21, 1908, by flying for 41 miles, round the military ground at Issy, without descending. Thus the machine was proved successful.

The Voisin was a big biplane, and, like the Wright, it had a front elevator-plane. But, unlike the Wright, it had a big box-kite tail on which the rudders were mounted. The wings also had vertical partitions, the whole theory of the machine being based on that of the box-kite. It had no lateral controls, as the vertical partitions were supposed to keep it steady, which they did up to a point, but it was practically unflyable in any wind above a zephyr. The first machine had a 50 hp. 8-cylinder Antoinette engine, and the latter ones a 40 hp. Vivinus, an ordinary motor-car engine, heavy but reliable.

When the famous Gnôme rotary engine appeared in 1909 the first of them was fitted to a Voisin biplane by M. Louis Paulhan, who, later on, won the *Daily Mail* £5,000 prize for the London-Manchester flight. On this Gnôme-engined Voisin M. Paulhan abolished all previous records for distance and duration at the Reims Meeting in August, 1909.

A notable feature was the fact that the under-carriage, the tail-booms, and much of the internal structure were made of steel tubing, and today steel tubing is coming more and more into favor. The machine was heavy and clumsy, and not till the rotary Gnôme engine was introduced in 1909 did it ever put up a respectable performance. Thereafter various alterations in design were made, but the Voisin was never manufacturede in numbers until 1915, when the firm brought out a big bomb and gun-carrying biplane, strong and heavy, which, despite its comparative clumsiness, did useful work. This machine retained unmistakable Voisin features, especially its tubular structure.



The elevator control of the Voisin was operated by a rod from the front elevator to a wheel in front of the pilot, which was pushed forward to push the nose of the machine down, and pulled back to pull it up, a perfectly natural motion, easy to learn. The rudders were worked by wires leading to a pivoted bar on which the pilot's feet rested. Pushing the right foot steered to the right, pushing the left foot steered to the left, also a natural motion. The Voisin may be set down as the father of all "pusher" airplanes—that is to say, machines with the engine and its air-screw behind.

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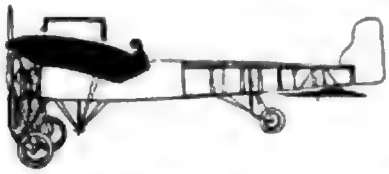
[*] Courtesy of the London Times.

The Bleriot Monoplane "Type XI," 1909

During 1908 M. Louis Blériot had been experimenting with monoplanes, in which he departed from his former cooperator's ideas by putting the engine in the nose of the machine with a tractor-screw in front of it. He also made a more or less fish-form—or stream-line—body, with the tail and elevator-planes horizontally, and the rudder vertically fixed at the rear end of it. This was the first successful "tractor" airplane, as opposed to the "pusher."

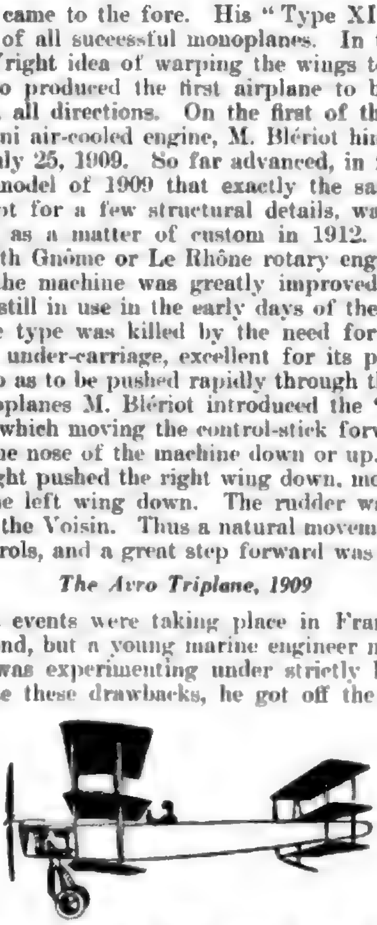


In 1908 M. Blériot achieved some success, but it was in 1909 that he really came to the fore. His "Type XI" machine is the prototype of all successful monoplanes. In this he incorporated the Wright idea of warping the wings to give lateral control, and so produced the first airplane to be thoroughly controllable in all directions. On the first of this type, with a 28 hp. Anzani air-cooled engine, M. Blériot himself flew the Channel on July 25, 1909. So far advanced, in fact, was this "Type XI" model of 1909 that exactly the same design of machine, except for a few structural details, was the first to loop the loop as a matter of custom in 1912. After 1909, when fitted with Gnôme or Le Rhône rotary engines, the performance of the machine was greatly improved, and several of them were still in use in the early days of the war in 1914. Ultimately the type was killed by the need for high speeds, as the Blériot under-carriage, excellent for its purpose, could not be made so as to be pushed rapidly through the air.

In his monoplanes M. Blériot introduced the "stick" form of control, in which moving the control-stick forward or backward moved the nose of the machine down or up. Moving the stick to the right pushed the right wing down, moving it to the left pushed the left wing down. The rudder was worked by the feet, as in the Voisin. Thus a natural movement was given to all the controls, and a great step forward was made.

The Avro Triplane, 1909

While these events were taking place in France little was done in England, but a young marine engineer named Aylwin Verdon Roe was experimenting under strictly limited conditions. Despite these drawbacks, he got off the ground on a "canard" type biplane in 1908, and during the autumn of that year he proceeded to build a tractor triplane. By the summer of 1909 he had it completed, and in June he flew it over Lea Marshes. His power plant was a 9 hp. J. A. P. motorcycle engine, the lowest power which has ever flown an airplane. It was also the first successful triplane.



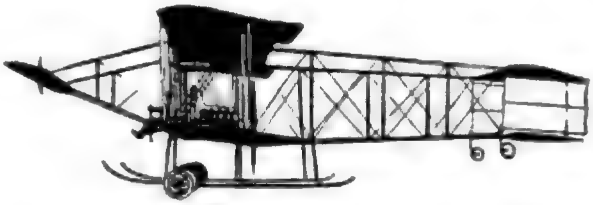
The machine had warping wings, tail elevators, and a rudder astern. In general lines and arrangement it is the prototype of all the modern tractor biplanes and multiplanes. The control was by stick and rudder-bar, much as in the Blériot, and as now used on nearly all airplanes.

This little machine was considerably developed during 1909 and 1910, so that by 1910, with an 8-cylinder J. A. P. engine it had become a really good flying machine. Then Mr. Roe abandoned the triplane in favor of the biplane, which he fitted with a British-designed Green engine of the vertical-cylinder type, and once more set a new fashion. Thereafter the triplane practically disappeared, till it was revived by British, French and German designers during the war—chiefly experimentally, for it has never become an accepted standard type.

Considerable space has been devoted to these first four airplanes, because from them are derived in one respect or another all succeeding types, as will be appreciated as we proceed with the study of their development.

The Farman Biplane, 1909

While M. Blériot was developing his monoplanes, Henry Farman also dissociated himself from the Voisin Brothers, and began experimenting on his own account. The result of his experiments was first seen at the Great Reims meeting in August, 1909, when his Gnôme-engined biplane appeared. Like the Voisin, it had a front elevator stuck out forward, but the vertical partitions had disappeared from the wings though retained in the tail. The whole machine was built of wood, so that it was very much lighter than the Voisin.



Its most remarkable step forward, however, was the use of balancing flaps—usually called "ailerons," or little wings—let into the rear edge of the end of each wing. These ailerons were pulled down on one side to give that side extra lift when the machine tilted down on that side. Thus the ailerons had the same effect as warping the wings, and, as it then became unnecessary to twist the wing itself, it became possible to build the whole wing structure as a fixed box-girder structure of wood and wire, lighter and stronger than was safe with a warping wing.

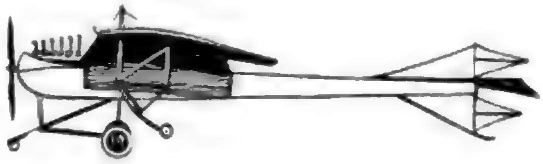
For this reason aileron control is used on all modern airplanes on active service.

The Farman biplane was fitted with the stick control used by M. Blériot, the stick working wires fore and aft for the elevator and laterally for the ailerons. A rudder-bar for the feet operated the rudder wires. So here we had the beginning of the modern idea of a "pusher" biplane.

The Antoinette Monoplane, 1909

Another great machine of 1909 was the Antoinette monoplane, evolved from the early experiments of MM. Gastambide and Mangin, and designed throughout by the famous engineer, M. Levavasseur, both airplane and engine. On one of these machines the late M. Hubert Latham only just failed to fly the Channel before M. Blériot. However, by the time of the Reims meeting in August it was in full working order, and during the last few days of the month there was a continual fight for the distance and durations "records" between Latham on the Antoinette, Paulhan on the Voisin, and Henry Farman on the Farman. The Antoinette was much the faster, but its engine always failed to hold out long enough to beat the others. However, the Antoinette showed itself in other ways to be the finest flying machine of the period, and it has never been surpassed for beauty.

It was the first machine in which real care was taken to attain a proper stream-line form in the body, and at the same time to make a proper engineering structure. The wings were orthodox king-post girders. The body was largely a box-girder composed of three-ply wood. The tail was designed like the feathering of an arrow.

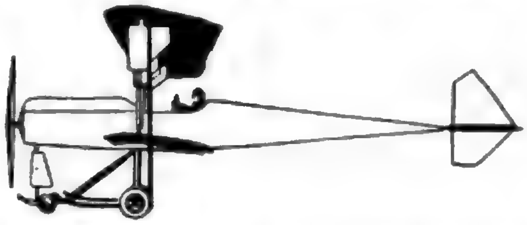


Unfortunately, the internal structure of later machines was bad, and many broke in the air, with fatal results. Also the control was most difficult to learn. One wheel worked the warping of the wings, another worked the elevator, and there was a rudder-bar for the feet. Consequently, the machines never became popular, and the last of them vanished in 1912. Nevertheless, the machine marked an epoch in that it was the first "eyeable" airplane, and it is a curious mechanical fact that a mechanism or an engineering structure which is fully developed and correct as a whole is also good to look at.

The Breguet of 1910

The year 1910 was somewhat bare as regards development, but it produced one distinct step forward—namely, the arrival of the tractor biplane, which is now the preponderating type in all countries.

The first machine of this type was designed by M. Bréguet, a rich French engineer, who had begun experimenting in 1908 or earlier. His first really successful machine appeared late in 1910. Early in the year he produced a primitive version of it, which was nicknamed the "Coffee Pot," as it was sheathed entirely in aluminum, and looked like a tin pot. This developed later into the type illustrated, which survived with minor alterations until the outbreak of war. During the war various Bréguets have appeared, both "tractors" and "pushers," and today the modern Bréguet is one of the best machines in the French service.



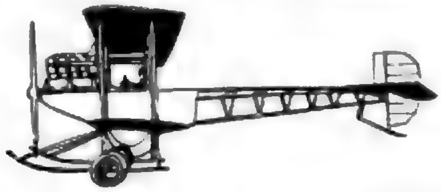
The machine shown had many interesting features. It was almost entirely composed of steel tubes, covered with aluminum plates—which led the uninitiated to call it an "armored warplane," which it was not. The tail, which was one piece with the rudder, was carried on a huge steel universal joint at the tip of the body, so that it swiveled up or down or sideways in answer to the controls. The wings had one enormous steel tubular spar, and consequently only one row of interplane struts. The controls were interesting. There was one wheel on the top of a pillar. Fore and aft rocking of the pillar controlled the elevator, rocking it sideways warped the wings, rotating the wheel operated the rudder. The arrangement was quite natural, and might have become universal practice but that by this date so many people could fly and all were used to the rudder-bar system.

The under-carriage had a wonderful oleo-pneumatic spring arrangement, which was highly satisfactory, and was the forerunner of many similar efforts, not yet perfected, which will come into their own in peace time when we can afford to carry a little extra weight on our great aerial liners.

The whole machine was enormously heavy, but it and its successors were fast and great weight-lifters. In fact, a Bréguet of later date lifted 10 (selected) passengers at once. Because of sundry minor defects in detail the machine never became popular, but it was certainly the first step toward the big tractor biplane of today. It is also of interest because a Bréguet seaplane was built very early in 1913 with a 200-hp. Salmson engine, and thus was practically three years ahead of its time in ideas of engine-power.

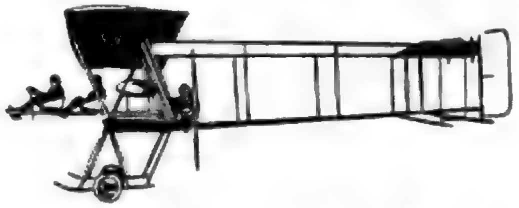
The Avro Biplane of 1910

Reference has already been made to the Avro Biplane. The first of these appeared late in 1910 with a little 35-hp. Green water-cooled engine. It was a small machine, astonishingly lightly constructed, but it proved to be exceedingly strong. Some of the leading people in the Flying Services today learned to fly on it, and it made numerous cross-country flights, one to Brighton and back. In its essential principles it was identical with the modern tractor biplanes. It marked a distinct step forward in that it showed the way toward the small, fast fighting biplanes of today, and also toward the bigger biplanes with fixed-cylinders, water-cooled engines.



The Henry Farman of 1911

The year 1911 produced two remarkable developments. The first was the abandonment by Henry Farman of the front elevator, and his adoption of elevator control on the tail alone, as was already the custom in monoplanes. The result was a curious-looking biplane retaining general Farman characteristics, but with the pilot and passenger sitting out in front of the machine on a thing something like a ladder, and apparently, like paupers, without any visible means of support.

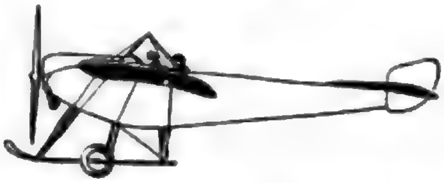


These machines showed remarkable increase of speed over the older types, owing to the reduction of head-resistance through the absence of the big front elevator, with all its booms and struts and wires, which actually did no manner of useful work.

Later on this ladder was boxed in with a light framework, covered with fabric, somewhat as in the first Voisin, but without the elevator, and so became what is called a "nacelle," which is French for cradle. Thus the 1911 Farnam became the forerunner of the "pusher" fighting machines, with a gun in front, commonly called "gun 'buses."

The Nieuport of 1911

The other remarkable step in 1911 was the monoplane produced by the brothers Edouard and Charles de Niéport, more commonly known as Nieuport. This machine had a very fat body, bluff in front and tapering well aft. The pilot and passenger sat close together right inside, with only their heads and shoulders visible.



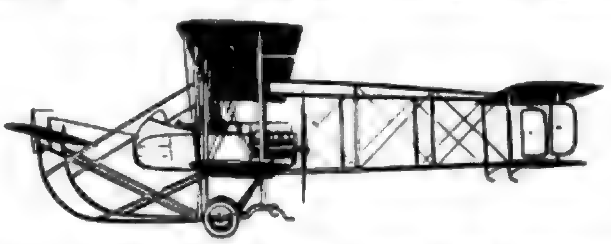
Everything outside the machine was faired off to the utmost degree, so as to reduce head-resistance. The under-carriage was reduced to a remarkable extent, consisting only of three V's of steel tube, of stream-line section, connected to a single longitudinal skid.

The result was a very fast machine, which, with only a seven-cylinder, 50-hp. Gnôme engine, attained a speed of about 70 miles an hour, and with the double-row Gnôme (14 cylinders of the 50-hp. type, alleged to give 100 hp., but really giving about 70 hp.) it reached between 80 and 90 miles an hour. In the Gordon-Bennett race in the Isle of Sheppey, the winner, M. Weymann, made an average speed of 79.5 miles an hour, so that, allowing for the corners, he must have been doing round about 90 miles an hour on the straights.

The fat stream-lined, all-inclusive body of the Nieuport was distinctly the originator of the body design of the fast tractor biplanes of today.

The Maurice Farman of 1912

A remarkable machine of 1912, itself a very busy year, was the biplane evolved by Maurice Farman, brother of Henry Farman. He had long been experimenting independently on lines halfway between the Voisins' and his brother's. The result was the machine illustrated. It represents the ultimate development of the machine with the front elevator. In the British military trials of 1912, with a 70-hp., air-cooled

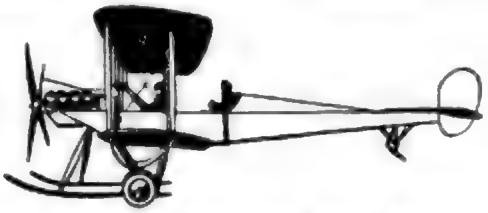


Renault engine, it performed excellently, and it survived as a training machine till well on in 1916.

It was probably the most comfortable machine to fly which has ever been evolved, and it was remarkably easy to fly, answering all its controls admirably. The deep nacelle gave the pilot excellent protection, and set a new fashion in nacelle design, which was developed in the "gun 'buses" of later date. On account of the long projecting horns which carried the front elevator, it was nicknamed "the Mechanical Cow," and when Maurice Farman produced a later type without the front elevator and the horns, the new type was called "the Shorthorn," while the 1912 type became "the Longhorn."

The First B.E. of 1912

During 1912 the Royal Aircraft Factory at Farnborough produced a notable tractor biplane, designed by Geoffrey de Havilland, one of the earliest experimenters in England.



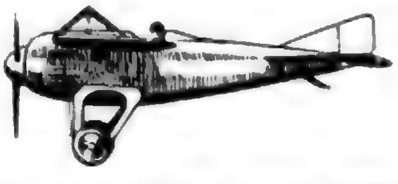
This machine combined something of the arrangement of the 1910 Avro, something of the fuselage lines of the 1910 Bréguet, and a little of the Nieuport tail design, but the detail design was entirely Mr. de Havilland's own. It was very light for its size and capacity, and with a 70-hp. Renault engine its performance was remarkable. Its speed was about 70 miles an hour, and it handled in the air and on the ground in a manner never before seen. It was the forerunner of a long line of R. A. F. designs, through all the range of B. E.'s, on to the R. E. series and the S. E. series.

It may be well to explain here that the initials B. E. originally stood for "Blériot Experimental," as M. Blériot was officially credited with having originated the tractor type airplane. Later B. E. was taken to indicate "British Experimental." The subsequent development into R. E. indicated "Reconnaissance Experimental," these being big biplanes, with water-cooled engines and bigger tank capacity, intended for long-distance flights. S. E. indicates "Scouting Experimental," the idea being that fast single-seaters would be used for scouting. They are, however, only used for fighting.

Another R. A. F. series is the F. E., all large "pusher" biplanes, descended from the Henry Farman. The initials stood originally for "Farman Experimental," but now stand for "Fighting Experimental," the type being variants of the Vickers "gun 'bus."

The Deperdussin of 1912

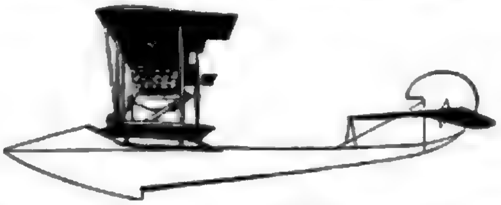
Possibly the greatest achievement of 1912 was the little monoplane designed for the Deperdussin firm by M. Béchereau and M. Koolhoven, to compete in the Gordon-Bennett race at Reims. This was a tiny machine with a 14-cylinder, 100-hp. Gnôme engine. It won the race, covering 126½ miles in the hour—the first time a man had beaten two miles a minute for an hour on end. Allowing for corners, its speed must have been well over 130 miles an hour on the straight, an uncommon speed even today.



Everything about the machine was stream-lined to the utmost, even to the extent of putting a stream-lined support behind the pilot's head. The under-carriage was reduced to two wheels, an axle, and four carefully stream-lined struts. This machine was the forerunner of all the very high speed airplanes of today. It was also remarkable for having its fuselage built entirely of three-ply wood, built on a mold without any internal bracing. The three-ply fuselage was adopted in all German fighting machines in 1916-17, and its merits are slowly being recognized in this country.

The Curtiss Flying-Boat of 1912

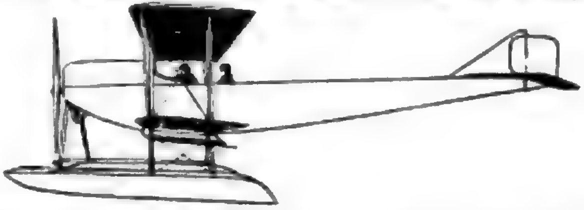
Another remarkable development of 1912 was the Curtiss flying-boat, the first American contribution to development since the Wrights first flew. Glenn Curtiss, who won the Gordon-Bennett race at Reims in 1909 on a very primitive biplane, largely by personal skill, had succeeded in getting off the water in 1911 with a similar biplane fitted with a central pontoon-float instead of a wheeled under-carriage.



This he developed into a genuine flying-boat, consisting of a proper hydro-plane boat, with wings and engine superimposed. From this have evolved all the great flying-boats of today, and it is the ancestor of the great passenger-carrying, ocean-going boats of the future.

The Short Seaplane of 1912

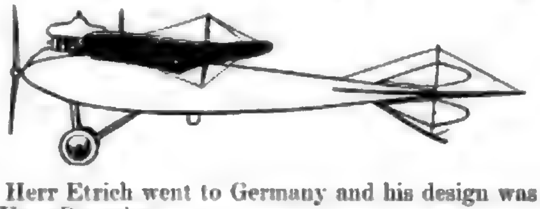
The other type of sea-flying machine also came to maturity in 1912, when, after much preliminary experimenting, the Short Brothers, of Eastchurch, developed a proper sea-going biplane, fitted with twin floats instead of the ordinary undercarriage. This, with only an 80-hp. Gnôme engine, was the first flying machine to prove its ability to get off or alight in anything of a sea, and today, with 300 hp. or more, it is able to face almost anything in which a vessel up to the size of a destroyer can travel.



Successors of this type have carried torpedoes and launched them successfully against enemy ships. They have patrolled steamer lines, and have escorted food convoys. They have sunk submarines, and they have bombed hostile positions over 100 miles from the sea. These Shorts were the ancestors of the small, fast-fighting seaplanes of today, having developed both upwards and downwards in the matter of size.

The Taube of 1912

Yet another 1912 development was the German Taube-type monoplane. "Taube" means Dove—not necessarily of Peace—and the type is so called because the wings are swept back and turned up at the tips like those of a pigeon. The originators of the type were Herren Wels and Etrich, in Austria, in 1908. Herr Etrich went to Germany and his design was taken up by Herr Rumpler.



This machine was designed to be inherently stable; that is to say, uncapsizable. In this, to a great extent, the type was successful. If it had room to recover its proper attitude before hitting the ground, it generally did so. Other designers, such as Mr. Dunne and Mr. Weiss in England, had striven likewise for inherent stability, but had failed to get past a certain point in development. The Taube went somewhat further, owing to greater financial support being obtainable in Germany, and the 1912 type survived with modifications far into 1915, when it was succeeded by the big German biplanes, possessing more speed and carrying power. Also, inherent stability was ultimately attained, with less waste of power, by British designers.

(To be concluded)

The Gallaudet Airscrew Propulsion Described

The system of airscrew propulsion herewith described is the invention of Edson F. Gallaudet of Norwich, Conn., who is known as a pioneer aviator and airplane constructor. It purposes to make possible the construction of airplanes fitted with a pusher airscrew without having recourse to the attachment of the tail planes by means of outriggers, or tail booms, the presence of which generates a not inconsiderable amount of parasite resistance.

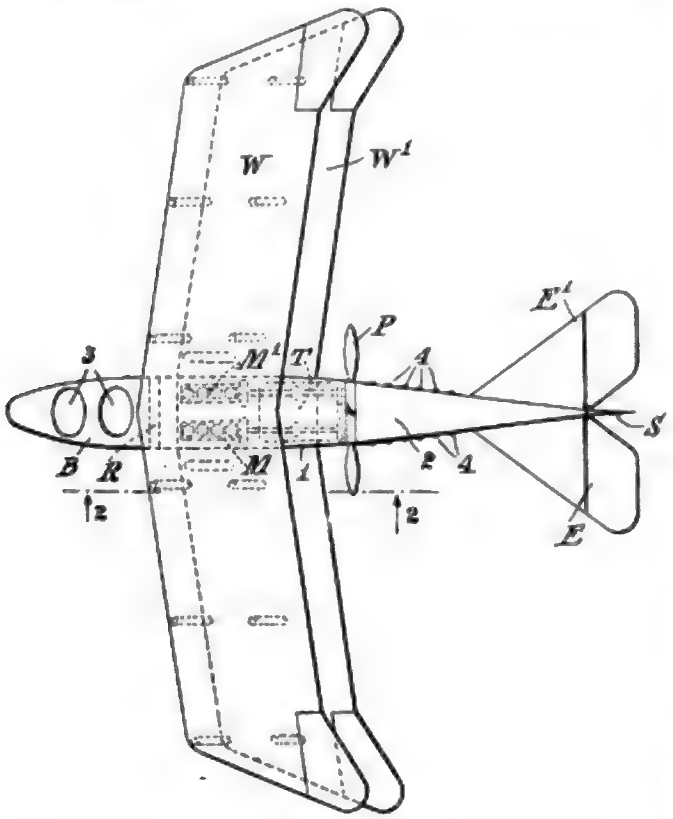


Fig. 1

Beside this, purely aerodynamic consideration which directly affects the efficiency of the airplane, military requirements also favor the development of a machine possessing an unrestricted arc of fire forward, which the synchronized system of firing through the blades of a tractor airscrew does not satisfy beyond reproach. Indeed, the synchronization of machine guns solidarizes the direction of the fire with the axis of the airplane, so that, in order to aim his gun, the pilot must head his machine straight against the target and no deviation of fire is thus possible.

With the Gallaudet airscrew propulsion this limitation of the present fighting plane is so much overcome that an arc of fire of over 180 deg. becomes available to a machine gun mounted forward on the body, as may be gathered from the accompanying illustrations.

In this connection it is interesting to note that high powered machines fitted with this system of propulsion have flown quite successfully, so the invention may be said to have passed the experimental stage.

The constructional features of the Gallaudet airscrew propulsion are set forth in the United States Patent No. 1,262,060 as follows:

"My present invention relates to flying machines of the airplane type, and more particularly to the construction of the body portion of such machines and to the mounting of the propeller thereon.

"The main object of the invention is to provide a body for a flying machine, of stream line form adapted to house and protect the motor or motors and associated power mechanism, which shall be both strong and light in construction and upon which the propeller is so mounted that it will be held rigidly in alinement with the power-shaft or shafts, that it will be protected largely from injury, and that it will assist in the cooling of the one or more motors employed.

"With this end in view the invention comprises certain novel features of construction, arrangement, and combination of parts hereinafter fully described and distinctly set forth in the appended claims.

"In the accompanying drawings, which form a part of this specification and wherein my improvements are shown, by way of illustration merely, as embodied in a biplane machine,—

"Figure 1 is a plan view, more or less diagrammatic, of the complete machine; Fig. 2, a section on the line 2 2 of Fig. 1, showing the body of the machine in side elevation; Fig. 3, a detail, in longitudinal section on the line 3 3 of Fig. 4, showing the mounting of the propeller; and Fig. 4, a transverse section on the line 4 4 of Fig. 3.

"Referring to the drawings, the machine illustrated comprises, as its principal parts, the upper and lower supporting planes W W′, the body B, mounted between the supporting planes and provided with suitable running gear, the propeller P, and the usual rear elevating planes E E′ and vertical steering rudder S.

"The hollow body of the machine, preferably pisciform or torpedo-shaped as shown, is formed by a thin shell of suitable material, steel for example, which is made in or divided transversely into two sections, a forward or main body section 1 and rear tail section 2, between which the propeller is mounted. The forward or main section of the body is provided with a suitable cockpit opening or openings 3 in its upper side forward, for the operator and his assistant, and within this section is mounted the power mechanism which comprises (as shown in dotted lines only) two gas engines M M′ and radiator R and fuel supply tank T, the radiator being set across the interior of the body in front of the engines. The sides of the tail section, which carries the steering rudder and elevating planes, are pierced and upset to provide louver-like openings 4 therein, or, in place of these openings, the bottom of this section of the body may be left more or less open.

"Within the rear end of the main body section, which is reinforced and stiffened internally by three flanged rings 5, 6, and 7, is mounted a drum 8. This drum, provided with outwardly projecting flange 9 at its forward and inwardly projecting flange 10 at its rear ends and an intermediate outwardly projecting flange 11, is held rigidly in place co-axial with the longitudinal axis of the body and extending somewhat beyond the end of the main body section by means of two sets of radial arms 12 and 13 which are respectively bolted or otherwise secured at their outer ends to the flanged rings 5 and 6 and at their inner ends to the flanges 9 and 11 on the drum. A second drum 14, of the same diameter as the first and provided with outwardly and inwardly projecting flanges 15 and 16 at its forward end and with outwardly projecting flange 17 at its rear end, is similarly mounted within and substantially flush with the forward end of the tail section of the body by means of two sets of radial arms 18 and 19 which are respectively secured at their outer ends to two flanged rings 20 and 21 attached to the walls of the body section and at their inner ends to the flanges 15 and 17 on the drum. This second drum is preferably closed at its rear end, to prevent the passage of air, by a plate 22 which may be provided with suitable small openings (not shown) through which to pass the wires used for the control of the steering rudder and elevating planes.

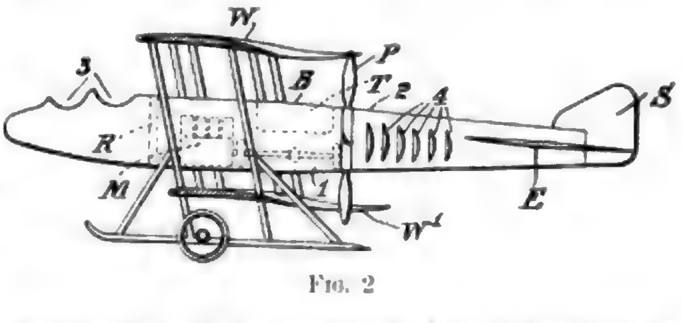


Fig. 2

"The two sections of the body (after the propeller and its ball-bearings, presently to be described, have been assembled and placed in position) are secured together by bolting the flanged front end of the drum 14 to the flanged rear end of the drum 8, leaving a narrow annular opening in the walls of the body between the adjacent ends of its main and tail sections within which the blades of the propeller revolve.

"The propeller (still referring to Figs. 3 and 4) consists of a spool or hub 23, provided with gear teeth 24 cut around its forward end and two outwardly projecting flanges or annular plates 25, which is mounted with suitable ball-bearings 26 to rotate upon the rear end of the drum 8, and blades 27 (shown as four in number, although the number is not material) which at their inner ends are bolted to the spool between the annular plates 25 and project outwardly through the opening left in the walls of the body. Between or alternating with the propeller blades, and similarly secured to the spool, are one (as here shown) or more short fan-blades 28, and bridge-pieces 29 in the form of segments of an annular plate, bearing against the outer ends of the intermediate fan-blade or blades, and secured by their flanged ends to the propeller blades to bridge the opening left in the walls and so maintain the contour of the body.

"Meshing with the teeth on the forward end of the propeller spool is a pinion 30 fixed to the rear end of a power-shaft 31 which is journaled in ball-bearings 32 and 33 suitably mounted, the former in one of the lower radial arms 12 and the latter in a corresponding arm 13 which support the forward drum. The flanged front end of this shaft is operatively connected in any suitable manner, preferably by a cone-clutch or other slightly flexible coupling, to the shaft of the engine M. A second pinion 30′, also meshing with the teeth of the propeller spool, is fixed upon the end of a power-shaft, corresponding to the shaft 31, which is similarly journaled in ball-bearings mounted in one of the lower radial arms 12 and 13 on the opposite side of the body and coupled to the shaft of the engine M′.

"The various parts described may be made of any suitable material, but, for the two drums, the propeller spool, and the driving pinions, I prefer to use the best chrome nickel steel, heat treated. In practice, also, I prefer to stiffen the construction by longitudinally cross-bracing each of the two sets of radial arms which support the drums, although I have deemed it unnecessary to show such cross-bracing.

"It will be seen that by the construction above described I secure what is in effect a light armored body, substantially inclosed on all sides and of stream line form, which houses and at the same time protects the engines and practically all of the power mechanism. The propeller, with only its blades projecting outside the body, is not only protected from serious injury but also serves as an exhaust fan to cool the engines, drawing air in at the cock-pit openings and back through the radiator past the engines and through the annual channel between the drums and the walls of the body, and exhausting it through the louver openings in the sides or through the open bottom of the tail section. Furthermore, a plurality of engines, one or all of which may be used as desired, are directly connected by spur gears to the single propeller, thus securing a maximum of efficiency and elasticity of power, while the power shafts and driving pinions are rigidly held in fixed alinement with the propeller spool no matter what the stresses to which the body of the machine may be subjected. Still other advantages will be apparent to a manufacturer or practiced operator."

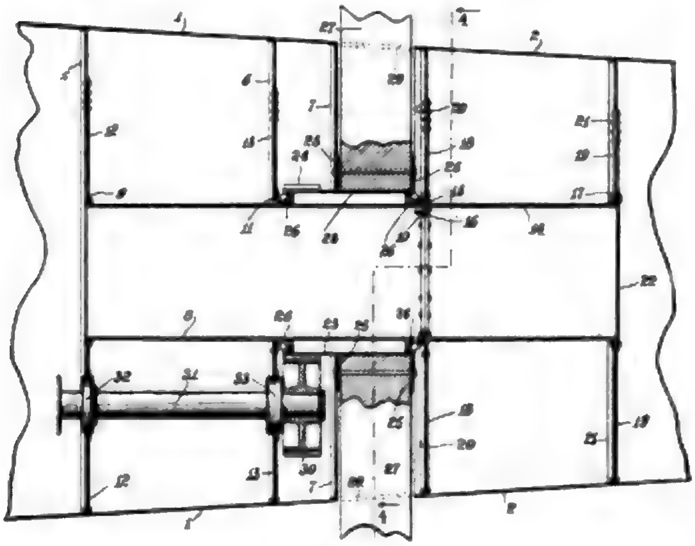


Fig. 3

The Claims

"1. In a flying machine, an elongated body which is substantially inclosed on all sides, a gas engine mounted within the body, a radiator for the engine set entirely across the interior of the body forward of the engine, and a propeller which is mounted within the body to the rear of and in operative connection with the engine and with blades projecting outwardly through a transverse opening in the walls of the body and is adapted to draw air through the radiator and assist in the cooling of the engine.

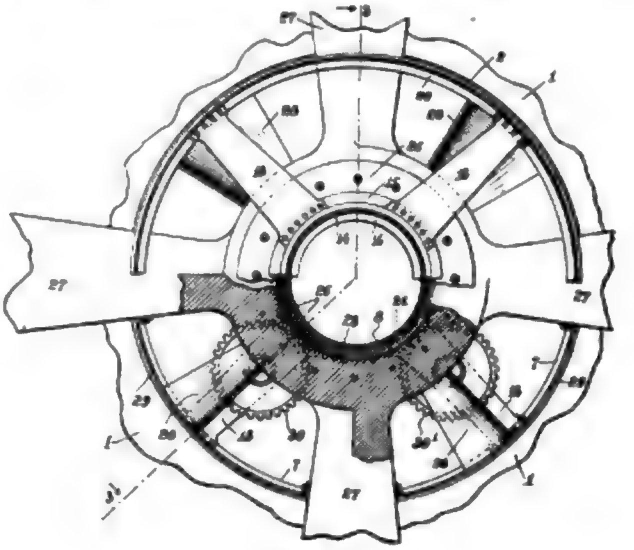


Fig. 4

"2. In a flying machine, an elongated rearwardly tapering body the walls of which are formed by a steel shell substantially inclosing it on all sides and power mechanism including a propeller and a gas engine and a radiator therefor mounted within the body, the radiator being set entirely across the body in front of the engine and the propeller being mounted to the rear of the engine co-axial with the longitudinal axis of the body with blades projecting outwardly through a transverse opening provided therefor in the walls and adapted to serve as a fan to assist in the cooling of the engine.

"3. In a flying machine, a hollow pisciform body, a plurality of gas engines mounted side by side within the body, a radiator for the engines set across the interior of the body forward of the engines, a propeller mounted within the body to the rear of the engines with blades projecting outwardly through a transverse opening in the walls of the body and adapted to draw air through the radiator and past the engines, and means for operatively connecting one or all of the engines with the propeller.

"4. In a flying machine, an elongated and substantially inclosed hollow body, a propeller mounted within the body co-axial with its longitudinal axis and with blades projecting outwardly through a transverse opening provided therefor in its walls, a plurality of engines mounted within the body, and means located within the body for operatively connecting each or all of the engines with the propeller.

"5. In a flying machine, an armored body substantially of stream line form, a propeller mounted within the body co-axial with its longitudinal axis and with blades projecting outwardly through a transverse opening in its walls, a plurality of driving shafts geared to the hub of the propeller and mounted to rotate in bearings rigidly secured in position relative to the bearings of the propeller, a plurality of engines mounted within the body, and means for coupling each engine with one of the driving shafts.

"6. In a flying machine, an elongated hollow body of substantially stream line form divided transversely into front and rear sections, a hollow cylindrical drum rigidly mounted within the adjacent ends of the two body sections coaxial therewith and serving to unite them together, and a propeller mounted to rotate upon the drum with blades projecting outwardly between the adjacent ends of the body sections.

"7. In a flying machine, an elongated hollow body of substantially stream line form divided transversely into front and rear sections, a hollow cylindrical drum rigidly mounted within the rear end of the front body section, a propeller mounted to rotate upon the drum immediately behind the rear end of the front body section, a driving shaft geared to the hub of the propeller and mounted to rotate in bearings rigidly secured between the drum and the walls of the body section, and means for securing the rear body section to the drum immediately behind the propeller.

"8. In a flying machine, an elongated rearwardly tapering body with walls formed by a shell which is divided transversely to form a forward main body section substantially symmetrical in transverse section and a rear tail section, a drum which is rigidly mounted co-axially within and extends slightly beyond the rear end of the main body section and to the rear end of which the tail section of the body is secured so as to leave a narrow transverse opening between the forward edge of its walls and the rear edge of the walls of the main body section, a propeller which is mounted to rotate upon the rear extended end of the drum with blades projecting outwardly through the opening between the adjacent edges of the walls of the main and tail body sections, and means for operatively connecting the propeller to a source of power located within the forward main body section.

"9. In a flying machine, an elongated rearwardly tapering body with walls formed by a shell which is divided transversely to provide a forward main body section and a rear tail section, a drum which is rigidly mounted by means of radial arms co-axially within and extends slightly beyond the rear end of the main body section and to the rear end of which the tail section of the body is secured, a propeller which is mounted to rotate upon the rear extended end of the drum with blades projecting outwardly through an opening left between the adjacent edges of the walls of the main and tail body sections, and a power-shaft geared to the propeller which is journaled in bearings mounted in the radial arms which secure the drum and is adapted to be operatively connected to the shaft of an engine located within the forward main section of the body.

"10. In a flying machine, a hollow pisciform body which is divided into front and rear sections, a drum which unites the two body sections and provides a bearing for a propeller co-axial with the longitudinal axis of the body, and a propeller mounted to rotate upon the drum which has propeller blades extending outwardly between the two body sections beyond their walls and, intermediate said blades, bridging pieces adapted to maintain the contour of the body and fan blades extending outwardly to the bridging pieces.

"11. In a flying machine, an elongated rearwardly tapering body which comprises an inclosed forward main body section adapted to receive and house the power mechanism and a rear tail section which is secured to the forward section near the longitudinal axis of the body so as to leave a narrow transverse opening in the walls between the adjacent ends of the two sections, a propeller which is mounted co-axially within the body opposite and with propeller blades projecting outwardly through the said opening in its walls and is provided intermediate the propeller blades with fan blades and with bridge-pieces adapted to bridge the opening therein and maintain the contour of the body, and a power-shaft geared to the propeller which is journaled in bearings holding it rigidly in position parallel to the axis of the propeller and is adapted to be operatively connected by a flexible coupling to the shaft of an engine located in the forward main section of the body.

"12. In a flying machine, an elongated rearwardly tapering body which is substantially inclosed and armored by a steel shell divided transversely into a forward main body section adapted to receive and house the power mechanism and a rear tail section, a steel drum which is rigidly mounted by means of radial arms co-axially within and extending slightly beyond the rear end of the main body section and to the rear end of which the tail section of the body is secured, a propeller which is mounted to rotate upon the rear extended end of the drum with its blades projecting outwardly through an opening left between the adjacent edges of the walls of the main and tail body sections and which intermediate its blades is provided with fan blades and with bridge-pieces adapted to bridge the said opening left in the walls and maintain the contour of the body, and a power-shaft which is geared to the propeller and journaled in bearings holding it rigidly in position parallel to the axis of the propeller and is adapted to be operatively connected to the shaft of an engine located in the forward main section of the body.

"13. In a flying machine, a hollow body of substantially stream line form divided transversely into two sections, a hollow cylindrical drum of smaller diameter rigidly mounted within the inner end of one body section co-axial therewith and projecting therefrom, means uniting the other body section to the projecting end of the drum, a propeller mounted to rotate upon the drum between the two body sections, a driving shaft geared to the propeller and journaled in bearings located within the first mentioned body section and rigidly secured in position relative to the drum, an engine mounted within the first mentioned body section, and means for flexibly coupling the engine with the driving shaft.

"14. In a flying machine, a hollow body of substantially stream line form divided transversely into two sections, a hollow cylindrical drum of smaller diameter rigidly mounted within the inner end of one body section co-axial therewith and projecting therefrom, means for uniting the other body section to the projecting end of the drum, two driving shafts geared to the propeller and journaled in bearings located within the first mentioned body section and rigidly secured in position relative to the drum, two engines mounted within the first mentioned body section, and means for flexibly coupling each engine with one of the driving shafts.

"15. In a flying machine, an elongated hollow body divided transversely into two sections, a hollow cylindrical drum of smaller diameter rigidly mounted within the adjacent inner ends of the two body sections co-axial therewith and serving to unite them together, a radiator set across the interior of the body and an engine mounted within one of the body sections, and a propeller mounted to rotate upon the drum between the two body sections and operatively connected with the engine."

Book Review

MILITARY AEROPLANES. 1918 Edition. By Grover C. Loening, B.Sc., A.M., C.E. ($4.75. 202 pp., fully illustrated.)

"Military Aeroplanes," by the author of "Monoplanes and Biplanes," is known to every serious student of aviation as one of the classics that grace the aircraft literature, and without which no aeronautical library may be said to be complete.

The 1918 edition of this book, which has just come off the press, marks a considerable expansion on earlier issues, while retaining all of the distinguishing features which have caused "Military Aeroplanes" to be recognized at large as one of the most valuable textbooks for student aviators, as well as an important reference work on airplane design.

Although the original text has not been altered to any extent, some very valuable chapters have been added thereto, and numerous illustrations of modern airplanes have also been incorporated. Among the latter one may mention the Porte flying boat, developed by the British Admiralty; the British S.E.5 pursuit biplane, the Handley-Page machine, etc.

A chapter, unusually well illustrated by descriptive diagrams, has been set aside for a discussion of the maneuvers involved in flying and "stunting." This chapter should prove of particular interest to student aviators, who will find therein a satisfactory explanation, well supported by diagrams, of such maneuvers as stalling, climbing, diving, skidding and side-slipping, the inversion of rudder and elevator, the feel of a proper turn, climbing on turns, the Immelmann turn, looping, nose spinning, etc.

While "Military Aeroplanes" cannot be called an elementary book because of the comprehensive manner in which the subject is covered, and also because of the valuable aerodynamic formulae it contains, the language used throughout has the merit of great clearness, so as to be wholly within the province of every serious student of aviation. One may add that the new edition is sufficiently different and enhanced in value as regards previous issues to warrant its study by all those who have read the latter.

In view of the above the book may be warmly recommended to all students who desire to acquire more than an elementary knowledge of the science of flying.

The Model C.V Albatros Biplane*—*Continued*

It has been said before that the Albatros biplane belongs to the German C-class, that is to say, is a general utility machine variously used for fighting, reconnaissance, artillery spotting and photography, and is therefore not to be considered a bombing machine. It is, however, provided with racks for a small number of bombs—four, to be exact—presumably for use in case of emergency when a suitable target might present itself. Fig. 25 is a diagramatic perspective view of the bomb racks and bomb gear. The bombs are secured underneath the main tank in the pilot's cockpit, but they are released by the gunner in the rear cockpit by means of a small lever and quadrant shown in the upper right-hand corner of Fig. 25.

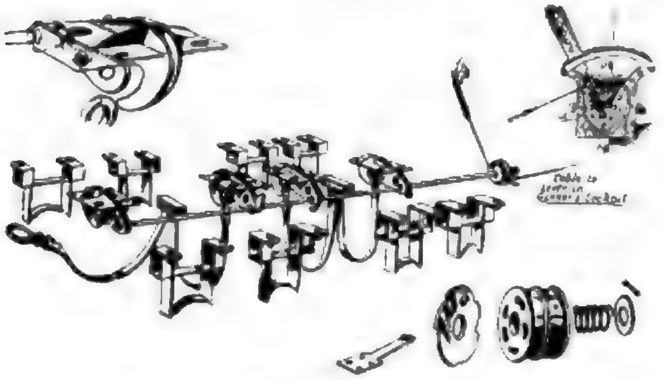


Fig. 25. Details of the Bomb Gear

The bomb racks are in the form of sheet steel supports, against the bottom of which rest the nose and the tail of the bombs respectively. These brackets are secured to transverse members in the bottom of the body, which have been omittted in the drawing for the sake of clearness. The bombs themselves are supported by a steel strap or band, passing underneath and approximately under the middle of the bombs. At one end straps are hinged, while at the other they are provided with an eye, which is secured in the hook under the release trigger. The sketch in the upper left-hand corner of Fig. 25 shows in more detail the hook in which the eye of the strap rests, and the trigger by means of which the strap is released. The trigger is pivoted near its center, and has an upward projection to which is attached a small coil spring resting in a groove in the base supporting the hook. When the cam on the transverse shaft presses down the rear end of the trigger, the front end moves upward against the tension of the coil spring mentioned above, thus releasing the strap and with it the bomb.

As regards the cams which operate the bombs these are mounted across the bottom of the body. There are four cams, each operating its trigger, but the gearing of the camshaft is such that it requires five pulls on the lever in the gunner's cockpit to rotate the shaft through a complete revolution. One of these pulls of the lever has no corresponding cam on the shaft, and has, it appears, the scope to provide an equivalent of a safety catch. When all the bombs are in place the first pull on the lever does not release a bomb, but merely brings the cam for bomb No. 1 into position, ready to press, on the next pull of the lever, the trigger for the first bomb. This has evidently been done as a precaution against accidentally releasing a bomb until the machine is approaching an objective.

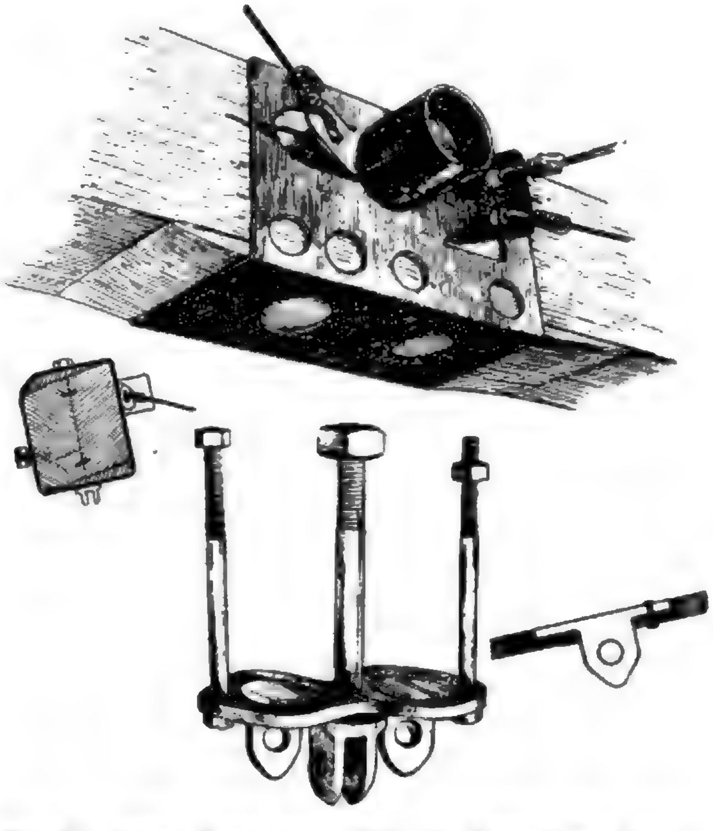


Fig. 27. Sheet Steel Spar Box and Socket for Compression Tube of the Upper Plane and Attachment of Terminals for Interplane Cables and Struts

We now come to consider the method of operating the transverse camshaft. Near the right-hand side of the body there is mounted on the camshaft a small ratchet having five teeth as shown in the bottom right-hand corner of Fig. 25. On this ratchet is a small cam, roughly of cone shape. This cam engages with grooves in the pulley around which passes the operating cable. A small leaf spring engages at the proper

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* Courtesy of *Flight*.

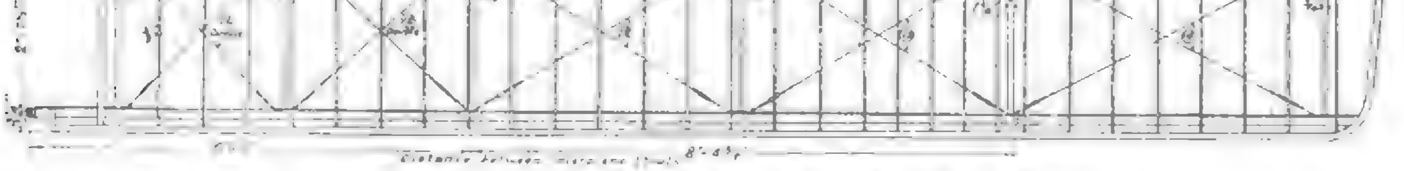
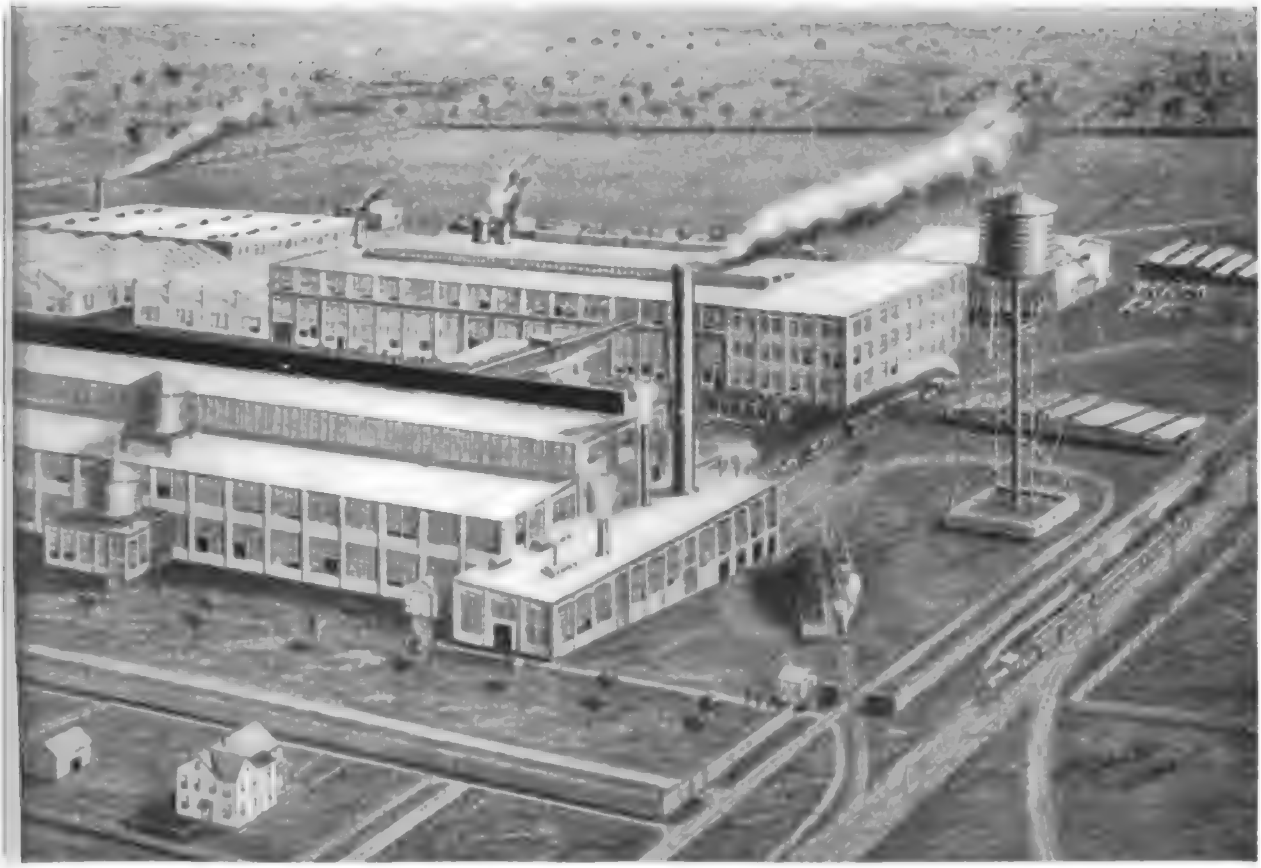


Fig. 26. General Arrangement of the Upper Left-Hand Wing

Second Lawson Aircraft Factory, December, 1917



Third Lawson Aircraft Factory, April, 1918

The Lawson Aircraft Corporation
Green Bay, Wisconsin

News of the Fortnight

The Aerial Mail Plans

Completion of arrangements for the first aerial mail route to be established in the United States, and plans as to train connections for saving of time in the dispatch and delivery of mail matter are announced in a statement just issued by the Post Office Department.

The statement reads:

The three landing fields for the aerial mail service have now been selected and the work of preparing the fields and erecting the hangars will be pushed as rapidly as possible. The service will be in operation not later than the 15th of May. The date of its inauguration may be advanced considerably.

The three landing fields selected are Potomac Park for Washington; Bustleton, North Philadelphia, for Philadelphia; and Belmont Park for New York.

Difficulty was experienced in the selection of a landing site for New York on account of the high rental asked for a suitable property. The Westchester Racing Association, in a spirit of patriotism, tendered Belmont Park to the Government for this purpose free of charge, and the offer was accepted.

The hangars at Potomac Park are now in course of construction and the work at Bustleton and Belmont Park will be speedily begun. Extensive rolling and grading of the Philadelphia field is necessary, but the work will all be done during this month.

Assuming that the airplanes leave New York for Washington at noon and leave Washington at the same hour for New York, rail connections for destinations beyond these cities and Philadelphia will be made which would otherwise be impossible.

Besides the saving of much time in the delivery of letters addressed to New York, Philadelphia and Washington, there will be a large amount of time saved through making these connections for earlier trains to the points beyond the terminals. An airplane leaving New York at 12 o'clock, arriving at Philadelphia at 1.30, and at Washington at 3.30, earlier connections than those conforming to the train schedules from New York will be made with trains for Camden and Atlantic City, N. J.; Paoli, Lancaster, and Harrisburg, and Chester, Pa.; Wilmington, Del.; Port Deposit, Md.; Cape May, N. J., and Reading and Pottsville, Pa.

Mail arriving at Washington by airplane at 3.30 p. m. would make connection with the Baltimore & Ohio train leaving Washington at 4 p. m. for Cumberland, Md.; Grafton, W. Va.; Pittsburgh, Pa.; Cincinnati, Ohio, and St. Louis, Mo. It would also make connections with the Southern Railway train leaving Washington at 4.15 p. m. for Charlottesville, Lynchburg, Danville, Va.; Greensboro, Salisbury, and Charlotte, N. C.; Atlanta, Ga., and Birmingham, Ala.

The time saved on these connections would amount to eight hours or more. In order to make these connections by rail it would be necessary for mail to be dispatched from New York at 8 a. m.

On account of the more frequent train service and different schedules of trains going north, the saving of time would not be as great to outlying stations for north bound mail.

At New York earlier connections will be made for Bridgeport, New Haven, Springfield, Boston, Albany, Syracuse, Rochester, Buffalo, Cleveland, Toledo, Elkhart, and Chicago.

An airplane leaving Washington on this noon schedule would make the late afternoon city delivery over the entire city of New York. To make this delivery by train letters now have to be mailed before 9 a. m.

Many of the preliminaries in connection with the establishment of the first American aerial mail route having been disposed of, the postmasters at Washington, Philadelphia and New York have begun circularizing the business houses of these cities for the purpose of predetermining to what probable extent the new service will be patronized. The circular asks for a reply and comment upon any other feature of the program not covered by it.

The notice sent out from the Washington post office is dated April 19 and reads in part as follows:

"As you have doubtless observed by notices appearing in the local papers, the Post Office Department is contemplating the inauguration of airplane mail service between Washington and New York, beginning May 15, 1918. Tentatively the Department has in mind leaving Washington at 11.30 a. m. or 12 o'clock noon and New York at the same hour, feeling that the flights can be made in three hours. A stop will be made at Philadelphia in both directions, the running time between this city and Philadelphia being about two hours. It is thought that it would be advantageous to permit mail for this special dispatch to be deposited at the main post office and at the more important classified stations in the center of the city. If the dispatch were scheduled to leave Washington at noon the mail would have to reach the office or station about thirty minutes earlier. It is probable, however, that arrangements may be made to leave the city at 11.30 a. m., in which case the mail would have to close thirty minutes earlier. It is proposed to effect delivery of the letters the same day that they are mailed.

"In view of the facts set forth above, will you be good enough to let me know if you expect to patronize this service, and if so to what extent. Also, kindly let me have your views as to whether the hour for closing the mail here is satisfactory. The rate of postage to be charged on letters has not yet been determined, but it will not exceed twenty-four cents an ounce."

Licenses for Operation of Aircraft

The joint Army and Navy Board on Aeronautic Cognizance authorizes the following:

According to the presidential proclamation of Feb. 28, 1918, no aircraft may be operated by civilians over any portion of the United States, its territorial waters, its insular possessions, or the Panama Canal Zone without a license.

Licenses for the operation of balloons, airplanes, or hydroairplanes must be secured from the joint Army and Navy Board of Aeronautic Cognizance by all aviators except officers of the Army and Navy.

The office of this joint board has recently been established at 1607 H Street NW., Washington, D. C.

Applications should state the name of the operator, the machine to be used, the names of passengers to be carried, the identifying markings on the machine, and other details intended to assure the military and naval forces as to the identity of the aircraft. The application should also state when and where it is proposed to make the flight. Applications should be addressed to—

The Joint Army and Navy Board on Aeronautic Cognizance,
1607 H Street NW., Washington, D. C.

By direction of the President, Maj. Gen. George O. Squier, Chief Signal Officer of the Army, has been designated chairman; Col. H. H. Arnold, Signal Corps, United States Army, and Lieut. Col. Claude E. Brigham, Coast Artillery, National Army, have been detailed as representatives of the Army; and Capt. N. E. Irwin, Capt. T. R. Y. Blakeley, and Capt. F. H. Clark to represent the Navy Department.

American Inventors' Association Organized

Inventors from all parts of the country met in Washington on April 6 and organized the American Inventors' Association, with F. J. Heman of Seattle, Wash., chairman, and Charles Wales of New Haven, Conn., secretary, as temporary officers.

E. W. Dunn of Los Angles, Cal., and Frank Warrick of St. Louis, Mo., were appointed a committee on constitution and by-laws.

The purposes of the new organization are set forth in the following resolution:

"We, the undersigned Americans and other loyal inventors, have assembled for the purpose of organizing an association to actively aid and support the Government of the United States in the war against its enemies, and especially to expedite and facilitate the adoption of meritorious war inventions and devices, whether patented or otherwise, which have been or may hereafter be offered to the Government, by suggesting, furthering and urging upon Congress and the people of the United States the desirability of creating a Government board to promptly test, try out and pass upon all inventions or devices thus offered or tendered to the Government, and which might be of value to the Army or Navy in war; and to urge the enactment of necessary legislation by Congress to cover the expenses thus incurred."

Cross-Country Flights

Several cross-country flights have recently been made by American and Allied aviators. On April 7 Capts. Silvio Resnati and Ugo D'Annunzio, of the Royal Italian Flying Corps, and Lieut. Barr, A.S., S.C., flew in a Caproni biplane from Mineola, N. Y., to Washington, D. C. The aviators started from Hazelhurst Field at 10.30 a. m., heading for Washington via New York City, Princeton, N. J., and Philadelphia, and landed at Potomac Park at 2.30 p. m.

On April 15 Major Roy S. Brown, A.S., S.C., and an Army air mechanic flew in an American built machine propelled by a Liberty engine from Langley Field to Hazelhurst Field. The distance of 325 miles was covered in three hours and fifteen minutes, that is, at an average speed of 100 miles per hour.

On April 25 Commandant Georges Tulasne, Chief of the French Aviation Mission to the United States, and Lieut. Georges Flachaire, of the French Flying Corps, flew from Hazelhurst Field to Potomac Park and back again, thus gaining the distinction of having made the first circuit flight between New York and the national capital. The flight was made in a French Bréguet biplane propelled by a 300 hp. Renault engine. The aviators started from Hazelhurst Field at 9 a. m., and reached Washington at 12.15 p. m.; after having luncheon and attending to some business they started on their return trip at 3 p. m. and reached New York at 6 p. m.

Electric Hoist Manufacturers Form Association

The manufacturers of the United States have organized "The Electric Hoist Manufacturers' Association," comprising the following companies: The Brown Hoisting Machinery Co., Detroit Hoist & Machine Co., Euclid Crane & Hoist Co., the Franklin-Moore Co., Link Belt Co., Roeper Crane & Hoist Works, Shepard Electric Crane & Hoist Co., Sprague Electric Works, the Yale & Towne Mfg. Co.

The officers of the Association are as follows: F. A. Hatch, Chairman, Shepard Electric Crane & Hoist Co.; F. W. Hall, Vice-Chairman, Sprague Electric Works; C. W. Beaver, Secretary-Treasurer, the Yale & Towne Mfg. Co.

The Association holds monthly meetings for the purpose of studying the specific needs of the hoist user and to develop standardized methods of presenting information to him so that guess work will be eliminated.

The membership of the Association is confined to those engaged in the manufacture of monorail electric hoists, which have revolutionized the handling and transportation of material in and about industrial plants.

Foreign Officers Make Exhibition Flights

Lieut. Col. Charles F. Lee of the Royal Flying Corps, in an Avro machine, and Capt. Silvio Resnati of the Italian Flying Corps, in a Caproni, made flights at Potomac Park, Washington, D. C., during the afternoon of April 14. Both machines were in the air at the same time and performed a series of war maneuvers and aerial acrobatics.

The exhibition was witnessed by a large crowd, including representatives of the various military missions and diplomatic corps.

Lieut. John A. Sully of the Royal Flying Corps had planned a flight in an Avro on the same day from Washington to Philadelphia, where he and Lieut. Georges Flachaire, an ace of the French Flying Corps, were to give an exhibition, but after starting, he was prevented from proceeding by engine trouble. Nevertheless, Philadelphians as well as Washingtonians were treated to flying thrills by Lieut. Flachaire in a Spad at the Belmont plateau.

Naval Aviation Stations Established Abroad

In an address at Cleveland, Ohio, on April 6, Secretary Daniels told of the great work of the Navy Department. Among other things he said that a torpedo station and aviation bases have been established abroad, and that American naval aviators are cooperating with those of England, France, Italy and Portugal.

Dayton Makes New Airplane Tire

The Dayton Rubber Manufacturing Co., Dayton, Ohio, has, according to reports, succeeded in making a cord tire for airplanes that weighs but 9 lb., against 14 lb. the weight of the next lightest tire. It is said that these tires will be turned out in large numbers to fill their contracts.

Secretary Crowell on Our Aircraft in France

Speaking at Washington on April 9, Assistant Secretary of War Crowell in an address on the issues of the war touched upon the airplane situation. He said the present situation on the battle front will be serious for a long time, but declared that reports that American soldiers have been compelled to defend themselves from German airplanes with pistols are not to be believed. He also said that there are more than 1100 qualified American Army aviators in France and that 1000 airplanes have been procured for their use from the French and Italians.

He added: "We are using great quantities of the Lewis gun in our airplanes, and, for a flexible aircraft gun we believe there is no equal to the Lewis gun."

The Reorganization of the Army Air Service

(Continued from page 447)

In 1898 he entered the employment of the Liberty Bell Gold Mining Co. of Telluride, Col., going the next year to Libby Creek, Mont., as a mill foreman. Then he entered the employment of the Atchison, Topeka & Santa Fe Railway as a mining engineer in the Industrial Department.

In 1902 he became a member of the firm of Dickman, McKensie & Potter of Chicago, but in 1903 he took the management of the Guggenheim Exploration Co. in the City of Mexico. From 1905 to 1911 he was general manager of the Southern Department of the American Smelting & Refining Co., with headquarters at Aguascalientes, Mexico.

Next he was made president of the Intercontinental Rubber Co. of New York. He resigned to accept the first vice-presidency of the Guaranty Trust Co. of this city in 1912, relinquishing this position in 1916 to join the firm of Guggenheim Bros., 120 Broadway. He became president of the Braden Co. and vice-president of the Chile Exploration Co.

On Jan. 2, 1918, he entered the service of the Government in the Equipment Division of the Signal Corps, and, naturally, is familiar with the present perplexing aircraft production situation.

Mr. Potter was married in Chicago in 1902, his bride being Miss Caroline Morton, daughter of the late Paul Morton, former Secretary of the Navy and later president of the Equitable Life Assurance Society. They have two daughters, Jean and Charlotte. Charles H. Sabin, president of the Guaranty Trust Co. of this city, is his brother-in-law.

Among his clubs are the Links, Metropolitan, National Golf Links, Shinnecock Hills Golf, Racquet and Tennis, Piping Rock, Rocky Mountain, Bankers' Club of America, Recess and the Club of Royal Game.

By his associates Mr. Potter is regarded as eminently qualified to carry out successfully any undertaking to which he may be assigned by the Government.

Brig.-Gen. William Lacy Kenley

Brig.-Gen. William Lacy Kenly, who heads the new Division of Military Aeronautics, is a native of Baltimore, Md., and was born on Feb. 18, 1864. He was a cadet at West Point Military Academy on Sept. 1, 1885, and was commissioned second lieutenant in the 4th Artillery on June 12, 1889; was graduated from the Artillery School in 1894 and successively appointed first lieutenant on June 29, 1896; captain in the Artillery Corps on Feb. 2, 1901; major on April 5, 1907, and assigned to the 5th Artillery on June 5 following, and reassigned to the 5th Artillery on Oct. 25, 1911; lieutenant-colonel in the 6th Field Artillery on Aug. 26, 1912, and brigadier-general on Aug. 5, 1917.

He has seen continuous service and was in the Spanish-American war and in Caper's battery in the Philippines, was head of General McArthur's staff and was on the Mexican border for two years, 1915-1916.

For six months in 1916-1917, General Kenly was in charge of the flying school at San Diego. He took a regiment of artillery to France last year and was chief of the aviation service of the American Expeditionary Forces for several months. He returned to the United States March 5, 1918, on orders to report for aviation duty, but first spent about six weeks in France and England. Since his return General Kenly has made an investigation of balloon schools in Louisiana, Indiana, Texas, Oklahoma and Nebraska, making the tour by airplane.

MAY 15, 1918

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THEORY OF THE AIRSCREW
THE EVOLUTION OF THE AIRPLANE
SOME PROBLEMS OF AIRPLANE DESIGN
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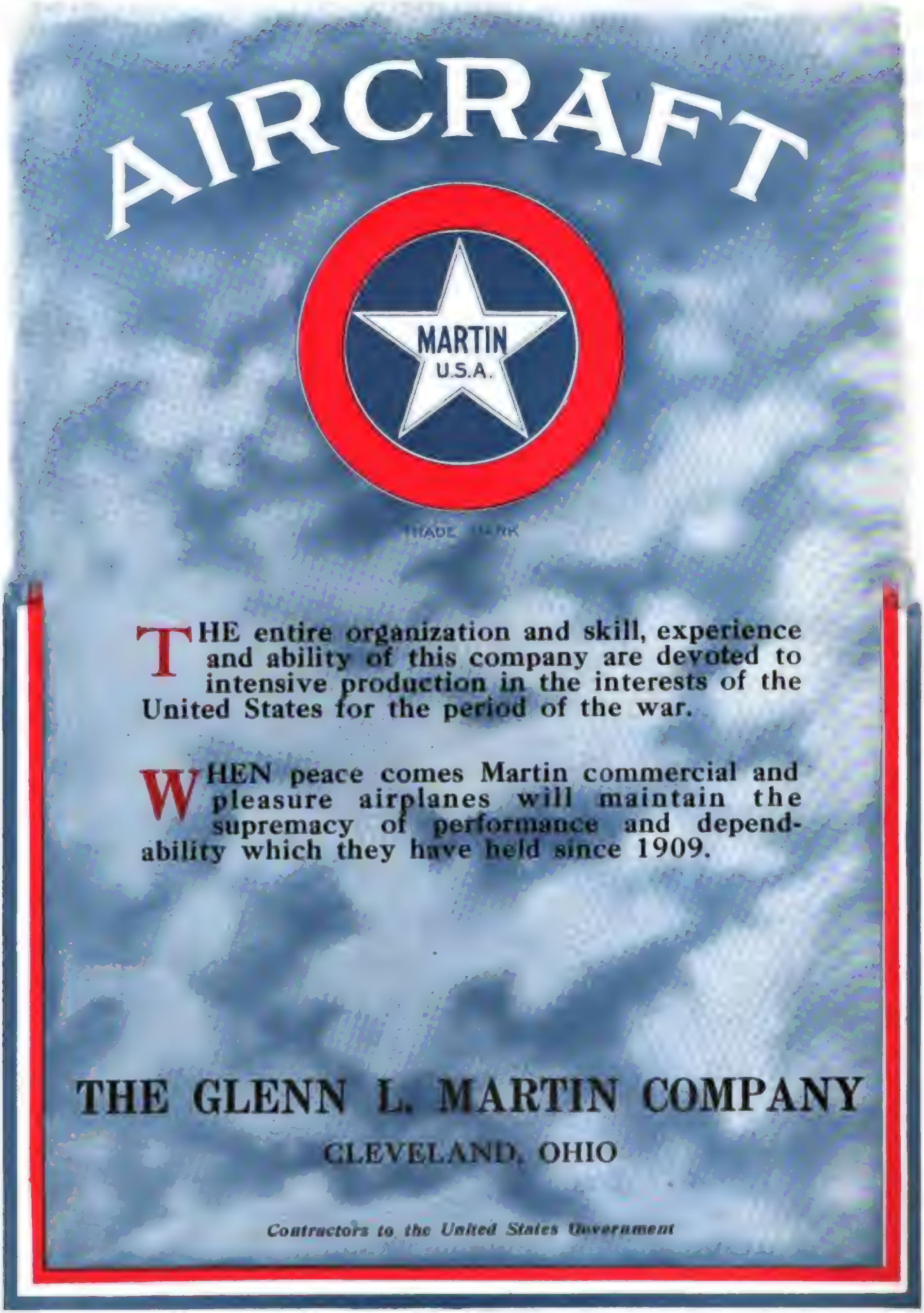

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Vol. IV May 15, 1918 No. 8

Theory of the Airscrew

By Professor Georges de Bothezat

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AVIATION AND AERONAUTICAL ENGINEERING *takes this opportunity of presenting to its readers a general outline of the results obtained by Professor Georges de Bothezat, late of the Polytechnic Institute of Petrograd, in his investigations of the mechanics of the airscrew. The results of these investigations, which are set forth in the form of a new theory of the airscrew, constitute a worthy scientific achievement which promises to have a marked influence upon this branch of aeronautical engineering both in the matter of primary conception and technique.*

Professor Georges de Bothezat, who is a Russian by birth, enjoys an international reputation among investigators of aerodynamics as the author of the first mathematical treatment of airplane stability, which he published in 1911, in Paris, under the title of "Etude de la Stabilité de l'Aéroplane" and which has since served as the fundamental treatise of this problem.

Having graduated from the University of Paris with the degree of Doctor of Sciences, M. de Bothezat was appointed by the Russian Minister of Instruction to fill the chair of applied mechanics and aerodynamics of the Polytechnic Institute at Petrograd. In this capacity he has made a number of valuable contributions to the science of hydrodynamics, aerodynamics, and aerial ballistics.

In the theoretical domain M. de Bothezat claims the authorship of several important works dealing with hydrodynamic resistance, the theory of the airscrew, and the determination of the definite oscillations of the airplane; in the practical field he created an original system of airscrew standardization and discovered the principle of the "invariable vertical" which he claims is of the greatest importance in insuring the correct aim of aircraft bombs.

M. de Bothezat is also the creator of two new types of airplanes, one of which he built in Russia during the war and fitted with his own type of airscrew. This machine has been tested in flight and has given results wholly in accord with the expectations of its builder.

The Bolshevist revolution having rendered impossible his continuing scientific work, M. de Bothezat decided to flee Russia; this he succeeded in doing at the peril of his life by travelling from Petrograd to Mourmansk in a cattle car, owing much of his escape to the "heroic devotion of the American Embassy officials and the officers of the American Military Mission to Russia" as he terms it. As M. de Bothezat has been fortunate enough to save from the Russian upheaval his most important scientific papers, one may entertain the hope that Russia's loss will eventually prove America's gain.

PROFESSOR GEORGES DE BOTHEZAT

The present theory gives a complete picture and an exact quantitative analysis of the whole phenomena of the working of the screw. This theory not only includes all the cases of its application, but also unites in a continuous whole the scale of states of work conceivable for a screw.

For studying the phenomenon of the working of the screw, I adopt as fundamental parameter a quantity which I call *relative pitch*. The relative pitch is the pitch of the trajectory of an element of the screw blade, measured by taking the pitch of the blade element as unity. I call the relation of the work of the thrust to the work of the torque applied to its axis the *specific function*. The curve of the specific function, as shown in the accompanying diagram, unfolds the completed cycle of the whole states of work possible for a screw.

For negative values great in absolute value of the relative pitch, the specific function is directed towards the origin of the co-ordinates by a sensibly rectilinear parabolic branch. Here we find ourselves in the region of the screw working as a brake, characterized by the fact that the current of water crossing the area swept by the blades of the screw has the same direction as the speed of the fluid current directed on the screw. The segment of this branch of the specific function which is directed towards the origin, as indicated by dots on the diagram, corresponds to a phenomenon discovered by me, in a purely analytical manner, for the first time in the present theory and named by me the *vortex ring working state*.

This phenomenon takes place in the following order: We imagine the screw working in the state of brake as above mentioned and consider the progressive lessening of its translational speed. In these conditions a moment arrives when a surface of discontinuity is formed in the wake of the screw across which the fluid will not flow.

Directly after its formation the surface of discontinuity divides into two surfaces and a vortex ring, the axis of which coincides with the axis of the screw, and appears in the space thus formed. The two surfaces of discontinuity which enclose the vortex ring move progressivelly apart, and a moment arrives when one of these surfaces crosses the space swept by the blades of the screw. This moment corresponds to the change of direction of the stream of fluid which flows across the plane of the screw and at once the screw inclines to make an infinite number of revolutions.

The curve of the specific function arrives at the origin by a cusp point. This is the whirling phenomenon,[1] immediately followed by a new brake state of work represented by a loop on the curve of the specific function. This latter state of brake work is terminated by the work of the screw at a fixed point. The screw fulfills then the functions of ventilator, helicoidal pump or helicopter. We immediately enter the region of positive values of the relative pitch. The screw becomes propulsive and the specific function represents the efficiency of the propeller.

After having passed a maximum, the specific function diminishes rapidly and passing through nil value brings us to a short interval of brakeage, which makes us pass asymptotically to the turbine work of the screw. In this latter interval the specific function represents the inverse of the efficiency of the turbo-motor.

After having passed a minimum which corresponds to the maximum of the turbo-motor efficiency, the specific function, by a parabolic branch, quasirectilinear, disappears into infinity, corresponding to the stoppage of the screw in a current which is directed on the screw. All this sequence of phenomena corresponds to the rotation of the screw in one sense. By the rotation of the screw in inverse sense, we obtain a series of phenomena of reverse rotation, which form, as it were, the reflected image of the forward movement.

The general equation of the specific function obtained leads directly to the determination of the most favorable conditions of screw-working in all the series of its applications. The maxima and minima of the specific function correspond exactly to the maximum of efficiency of the different states, separated from one another by the nil and infinite values of the specific function. We are thus naturally brought to the methods of calculation of the screw consequent on the conditions of its maximum efficiency.

The system of fundamental equations obtained by us thus shows all the properties of the screw in all the variety of its different working conditions. We thus obtain a complete solution of the whole series of those important problems which have been standing so long, owing to the requirements of practice in the applications of the screw, and which have, up to the present, remained without any satisfactory solution.

I have arrived at all these results, on the one hand, by the conceptional definition of the screw problem of which the normal working conditions are the expression, and, on the other hand, by the employment of a method of solving hydrodynamic problems, which I call the *empirico-theoretical method*. These two sides of the question are of such importance that I must stop to examine them generally.

When a new problem is raised, before proceeding to its soluton, two stages should be distinguished. The first is that where the thought seeks to formulate the statement of the question. It is only afterwards, when the problem has been formulated, that we can, properly speaking, approach a solution.

All the great scientific conquests of human thought have always begun by a partial conception of the problem to solve. The conceptional definition of a problem is distinguished by the fact that it is only an abstraction from the world of our sensations, only a mental approximation of the reality of the external world.

A simple example will suffice to give point to my idea. Let us take the problem of the motion of a rigid body. It is a well known fact that in nature no solids exist in the absolute meaning of mechanics. So, all the mechanics of the solid is only an approximation of reality; but the whole value of this approximation lies in the fact that numerous natural bodies approach in certain conditions so nearly to an absolute rigidity that the established laws of the mechanics of solids give a description of actual solids, which, in general, exceeds all the demands of applied science.

The problem once stated, an exact solution can be sought. It is only of the exactitude of the solution that there can be any question. All problems in themselves can only be an approximation of reality. That is why we should never persist too much on finding exact solution of problems which present too considerable difficulties. The whole value of the numerous methods of approximation lies in the fact that the results obtained are, so to say, of the same degree of exactitude as the conception of the problem. Important problems remain long without being solved, only because their very conception has not been sufficiently thorough. The screw is such an example. A more thorough conception, while making the solution easier, often brings us still nearer to reality.

The empirical-theoretical method to which I have had recourse for the solution of the screw problem, presents a certain analogy to the general method of solving problems of the theory of elasticity. At one time, scientists tried to deduce the elastic properties of solids starting from the hypothesis of the molecular structure of bodies. But the real progress of the theory of elasticity was only obtained when this risky method was abandoned.

In order to establish the elastic properties of solids, the modern theory of elasticity has recourse to direct experiment, and based on the data of this latter, it connects the complex cases with the simple by the help of the fundamental propositions of mechanics. This, in my opinion, is what should be done with regard to the solution of the problem of hydrodynamic resistance. Find out the factors which depend on the physical nature of the fluid and the surfaces in contact, and for their numerical value fall back on direct experiment. But from the knowledge of these factors, once they are determined, the results that mechanics allow of being established must be drawn.

The methods which have been proposed for the solution of the problem of the hydro-dynamic resistance of fluids have as a rule the following scheme: First of all, the fixing of the fundamental characteristics of the stream around the solid in motion is sought. Then the distribution of velocities in the fluid mass is determined; from these latter we go on to the pressures of which the results on the surface of the body ought to represent the hydro-dynamic resistance of the fluid. Thus Euler's method consists in supposing the flow of the fluid to be continuous and allowing a potential function for speeds.

This conception of the phenomenon leads to the conclusion that all bodies immersed in a fluid do not show any hydrodynamic resistance, which is in flagrant contradiction to experience. In order to explain the phenomenon of resistance, Helmholz has supposed the formation, behind the body, of surfaces of discontinuity, to which he had been led in studying the flow of fluids through orifices. This method has been developed by Kirchoff and Lord Rayleigh. The value of the hydro-dynamic resistance obtained by this method is, however, inferior to that furnished by experiment. The cause of this divergence lies in the fact that this type of flow is unstable, the viscosity of the fluid destroying the surfaces of discontinuity.

Of late years, M. W. Kutta[2] having established, in the case of movements parallel to a plane, the relation between the circulation over a definite outline which encloses a cylindrical solid and its hydro-dynamic resistance, tried to determine this latter by studying some types of flow of fluid around the solid, which, although stream-line, furnishes a definite value of the circulation around the cylinder. To Messrs. Tchapliguine and N. Joukowski[3] we owe numerous developments and applications of this method. The authors of this theory have been able to calculate the lift furnished by the cylindrical solid, but a value which does not agree with experiment, namely, the drift, escaped their investigations. I shall therefore en-

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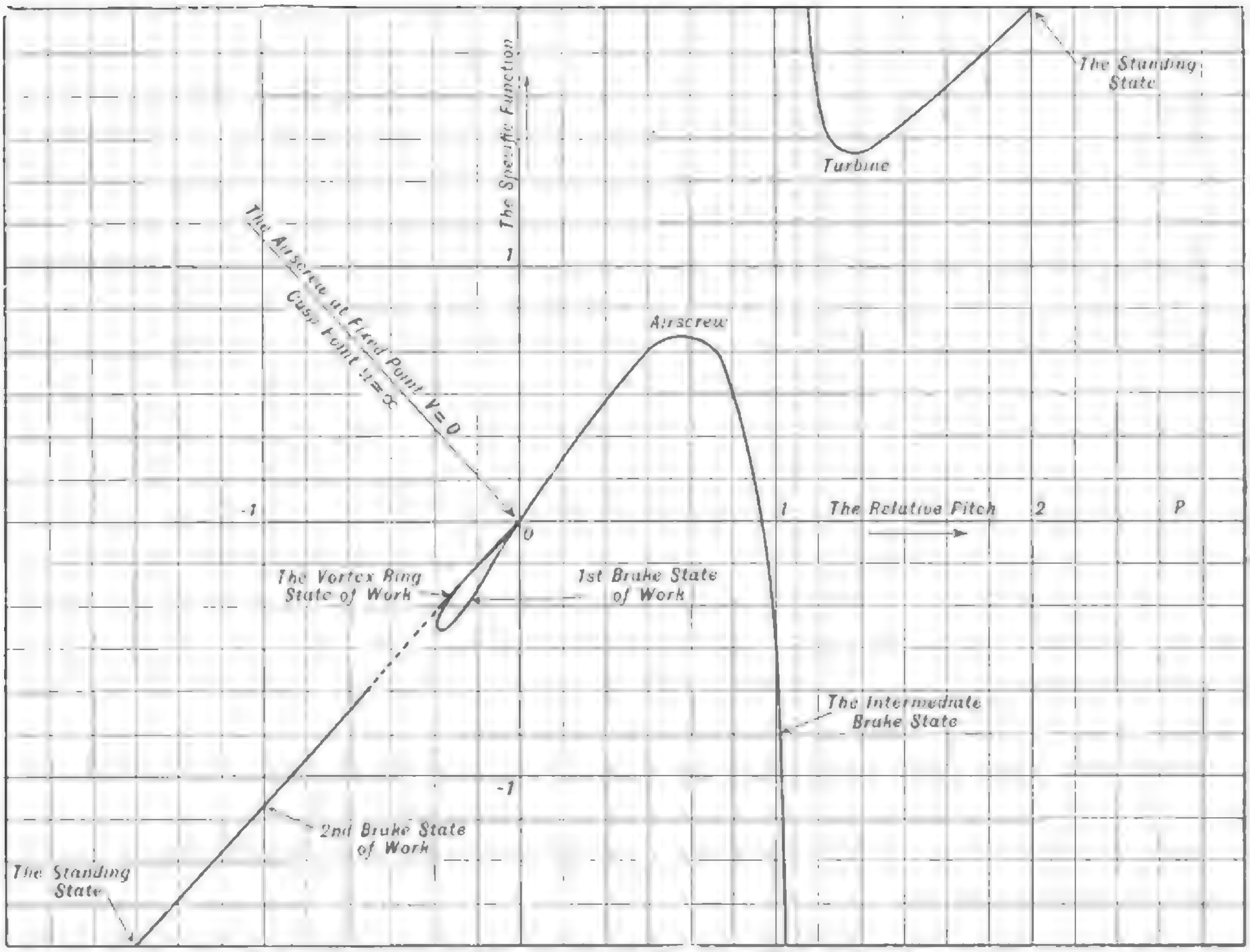
[1] The whirling phenomenon is often observed in the braking of ships by means of the screw. At that moment a sudden jerk on the engines is observed, and the engines themselves tend to accelerate. In practical navigation this phenomenon has always been considered as accidental. It is however, quite a regular phenomenon, which detects the moment of change in the direction of the stream of water which flows across the screw.

[2] See W. M. Kutta, "Illustrirte Aeronautische Mitteilungen," 1902. "Sitzungsberichte der Koeniglichen Bayerischen Akademie der Wissenschaften. Munich, 1910 and 1911.

[3] See *L'Aérodynamique* de N. Joukowski. Paris, 1916. Chap. VI, paragraphs 18, 19, 20.



General Analytical Diagram of All States of Work of the Screw

deavor to give a general demonstration of the theorem of circulation which explains this misunderstanding.

This theorem does not furnish a nil value of the drift and its authors arrived at this conclusion only by the fact of supposing the fluid to be perfect, an hypothesis quite superfluous and entirely unnecessary for establishing this theorem. But this theorem itself, understood in its widest sense, does not lead to the solution of the problem of hydro-dynamic resistance, since the values obtained for the circulation depend on the type of flow supposed, and which always remains to be determined. This latter question, of the type of flow, is excellently stated by M. v. Karman,[1] who proposes to determine the hydro-dynamic resistance starting from the estimate of the momentum of the vortex in quincunx, which is formed behind the cylindrical solid in uniform rectilinear motion in a fluid. This theory, applied up to the present only to the most simple cases, gives results which agree better with experience.

All the attempts enumerated above, although quite erudite, cannot give us the value of the hydro-dynamic resistance for all the cases demanded by technique, and we are always obliged to resort to experiment for its determination. How ought we to proceed when a problem of hydro-dynamic resistance bars the way to our investigations? It is by the empirical-theoretical method that I find the means of circumventing this difficulty. This method really consists in reversing the question.

We do not propose to calculate the hydro-dynamic resistance from the type of flow of the fluid, but inversely, it is the flow of the fluid that we shall try to determine, starting with the knowledge of the hydro-dynamic resistance measured experimentally. In general the empirico-theoretic method is represented as follows: All the space in which a hydro-dynamic phenomenon has played is divided into two sorts of regions. In one of these the hydro-dynamic resistances are, so to say, concentrated; in the other, they are absent. The hydro-dynamic resistances once experimentally determined, the connection between the two sorts of regions is established by means of the general theorems of mechanics and hydrodynamics, the phenomena which take place in the second sort of regions being considered as under the laws of perfect fluids.

Returning to the general considerations of our screw problem I shall begin by defining this problem. As for all conceptional definitions this will only approximate reality to a certain degree. But the value of our method of formulating the problem lies in the fact that it leads us to a solution of this latter, which satisfies all the demands of the technique of the application of the screw.

The following, in accordance with the empirical-theoretical method is my conception of the screw problem. In order to fix our ideas we will allow that it is a propeller. I divide the stream of fluid into three regions. The first is that part of the stream which is placed forward of the screw and counted up to the section of the stream that the local phenomena caused by the rotation of the blades in the field have not reached. The second region, which contains the screw, immediately follows the first and encloses that part of the stream immediately disturbed by the rotation of the screw-blades. I determine this second region by the condition that the differences of pressures on the two limited sections is actually equal to the thrust produced by the propeller. The third portion is the direct prolongation of the second and extends up to the narrowest section of the fluid created by the whirl of the screw. I allow that the flow of fluid in the first and third regions obeys the laws of perfect fluids, while the phenomena taking place in the second region are estimated by globular estimation, by direct experiment. As regards the fluid stream from the third region, I allow that its speed is progressively reduced by the viscosity of the fluid. The conditions enumerated above are the *normal conditions of the working of the*

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[1] See v. Karman, "Nachrichten von der Koeniglichen Gesellschaft der Wissenschaften zu Göttingen," 1911. "Physikalische Zeitschrift," 1912.

screw. I call all the circumstances which deviate from normal conditions, *neighboring conditions.*

The conception of a problem can only be judged by the conclusions to which it leads. The results obtained by my theory, I hope, will be the most eloquent evidence in favor of my conception of the screw problem. I should like to mention that it has been quite impossible for me to deal with all the questions that my conception of the screw problem raises. I have concentrated my efforts above all on the problems which appear to me to be most important practically and the results I have obtained should suffice for the exact calculation of screws of the highest efficiency for states of working which I submit to detailed study.

I also wish to point out to those about to verify the present theory by experiment, two circumstances which disturb, as it were, the clearness of the phenomena: on the one hand, the deformation of the screw-blades, and on the other, the deviations of fluid resistances from the law of the square of velocities. It very often happens that when the angular speed of the rotation of the screw is increased, the blades undergo a certain distortion owing to the strain to which they are submitted. This causes a modification in the pitch of their sections which gives an immediate repercussion in the results of testing.

As for the law of the square of velocities, it can only be considered admissible in the first approximation, that is why it can only be applied at certain intervals of variation of velocity for which the co-efficients of resistance ought to be directly determined. When the co-efficients of resistance are taken as constant in the long intervals of variation of velocity, the results of the calculations raise differences which should be attributed to the deviations from the law of the squaring of velocities.

In conclusion I shall give a general summary of the chief results obtained at this time by my theory. The system of fundamental equations relating to the screw are first established. The theorems of momentum and of moments of momentum in their application to the screw are then examined, after which a complete picture of the movement of the fluid in the stream created by the rotation of the screw is given. The examination of the distribution of pressure in this fluid stream leads to the generalization of Bernouilli's theorem. It is shown that the *effective pitch* alone, as opposed to the *constructive pitch*, can serve to describe the properties of the screw. The fundamental theorem registering the losses in the work of the screw is established. The explicit expressions of the velocities in the fluid stream caused by the rotation of the screw, which I call *additional velocities*, are calculated both forward of the screw and in its wake—as functions of the dimensions of the screw and the co-efficients of resistance. Rigorous demonstration is given of the fact already known, but generalized by us, that the specific function is a function of the relative pitch alone.

The general discussion of the sixteen states of work which may be fixed for the screw is given afterward. The existence of the state of the vortex ring, as well as of the phenomenon of whirling, which enter the screw theory are submitted to general analytical examination. The general outline of the curve of the specific function is examined. Finally, I point out two limit cases of the work of the screw with a null constructive pitch and of the screw with an infinite constructive pitch. The consideration of the effective pitches immediately explains the paradoxes apparently realized by these cases.

After these general considerations I shall undertake the study of the propulsive screw. First of all, I shall give a comparative summary of the general formulae for the working of the screw when alvancing and when standing at fixed point. I thus establish the fundamental proposition that *when a screw is working at fixed point the angles of attack of all sections are constantly independent of the angular velocity of the rotation of the screw.* Then the losses of the screw's working power are estimated. These I divide into three classes: Loss in ventilation, loss in the vortexes, and loss in resistance. The most favorable working conditions of an element of blade are established. I establish the approximate proposition that when an element of blade works at its maximum of partial efficiency, its slip measures its loss, its efficiency is equal to its relative pitch. *An exact standard is given for choosing the most efficient shapes to adopt for screw-blade sections.* I deal with the question of the limit dimensions of blades, their limited number and their mutual influence. It is shown that for given conditions of working there exists a limit power that a screw can employ usefully. In the analysis of these questions the new notion of fulfilling is naturally evolved.

Among other experiments, those of M. Eiffel with two coupled screws, the nearing of which in the inverse sense of their rotation had increased the efficiency, finds a direct explanation. I then proceed to the summary valuation of the work of different sections of the blades. A geometrical interpretation is given to the problem of total efficiency, which establishes the direct relations between the partial and the total efficiencies. I examine the question of the effective pitch of the entire screw, and then pass to the integration of the work of different sections of the blade, with data of the different conditions which may be found in this integration. After an examination of certain properties of the integrals obtained, I compare the working of the propulsive screw in forward motion to its working at a fixed point.

The question of investigation of the best contour for blades is posed as a question of the calculus of variations. The problem of the calculus of the dimensions of propulsive screws is made the subject of detailed study. In order to solve the fundamental relations deciding the value of the angle of attack, which is effectively established in each section, and cannot be solved by ordinary methods, I have composed a monogram with four parameters, according to M. d'Ocagne's method of parallel tangent co-ordinates. A second monogram has been prepared in order to facilitate the calculus of the function az, and of the co-efficient of load q, but which evidently has not the importance of the former, since the relations for which it gives numerical values may be calculated directly. The problem of the calculus of propulsive screws is thus entirely solved in the widest sense for all practical demands.

Finally, I deal with the important question of the choice and adaptation of screws. I am led to establish the new notion of *uniform families of screws* divided into *varieties.* Up to now this has generally been limited to screws geometrically alike. I introduce the notion of the screws, which are, so to say, hydro-dynamically alike.

Passing to the comparison of screws among themselves, it is natural to imagine the different sections of blades in like working conditions, then we naturally come to functional relations connecting all screws of the same variety. Hydro-dynamic similarity is established when homologous sections of the blades of the screws of a family under consideration are geometrically alike, and when the fluid-current is directed upon them under the same incidence. It is thus that the notion of variety of a uniform family is revealed as characterized by the similarity of homologous sections of blades, independently of their effective pitch, and by the identity of the system $S\ (i)$ of effective angles of attack of all the sections of each blade of these screws.

But the introduction of the system of angles of attack $S\ (i)$ as a fundamental characteristic became possible when explicit relations were established between the effective angles of attack, the geometrical and hydro-dynamic characteristics of screws and their working conditions, results attained for the first time in this thesis. That is why we can now fix exactly in this way the mutual orientations of different sections of the blades to which those developed in the plane are geometrically similar. It is the latter possibility which renders the basis of the theory of uniform families and which leads us to the solution of the delicate problem of the choice and adaptation of screws. I divide the screws into three sorts—major screws, optima or maxima screws, and minor screws, all of which essentially differ in their general properties. I establish three fundamental relations connecting all the screws of one kind and allowing of a direct solution by the reading of a simple diagram of all the infinite series of screws which satisfy the conditions of velocity, power and number of revolutions for a given case.

I indicate the process of *the auxiliary trial (test) screw.* For choosing the propeller screw in cases when the drift or head resistance of the vehicle of locomotion in view is unknown, which is most usually the case in practice. The influence of the number of revolutions on the efficiency and dimensions of screws is examined in outline. The geometrical basis of the conventions used for screw design are also given.

The general theory of the screw leads to a new method of determining the co-efficients of fluid resistances based on the properties of the screw. This method forms, so to say, the basis of all the experimental data necessary for the calculus of screws in the same conditions of screw-working.

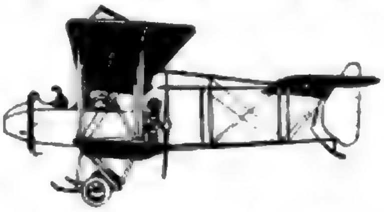
The Evolution of the Airplane*—*Concluded*

By C. G. Grey

Editor of The Aeroplane

The Henry Farman of 1913

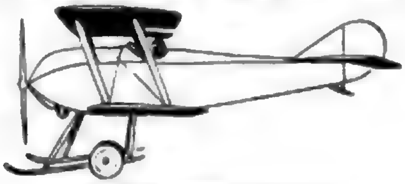
In the Henry Farman of 1913 we find the "pusher" design crystallizing into its ultimate form. The whole machine has become neater and more compact. The nacelle shelters the pilot reasonably well. The tail, elevator, and rudder form an eyeable unit, and the general effect is more workmanlike and less spread-eagled. This type was ultimately combined with the "Shorthorn" Maurice Farman into a composite machine nicknamed the "Horace"—a jesting combination of Henry and Maurice—which was doing good service in 1917, as a means of training and aerial travel rather than as a fighting machine. The 1913 type was a distinct step toward the Vickers and F. E. gun-'buses.



The Henry Farman, 1913

The Sopwith Tabloid of 1913

Here we have a machine which marked a startling development. T. O. M. Sopwith, himself a brilliant pilot; Mr. Hawker, a clever Australian pilot, and Mr. Sigrist, Mr. Sopwith's chief engineer, produced early in 1913 a tiny tractor biplane, with an 80-hp. Gnôme engine, which startled the aeronautical world by doing a top speed of 95 miles an hour, while possessing the ability to fly as slowly as 45 m.p.h. The result was obtained by skillful reduction of weight, by careful stream-lining of external parts, and by close attention to wing design.

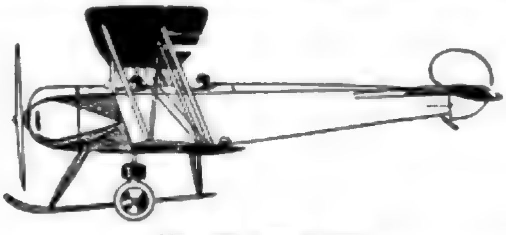


The Sopwith Tabloid

It was the first high-speed biplane, for hitherto monoplanes had always been considered faster than biplanes. All the high-speed fighting biplanes of today—"Scouts," "Pups," "Camels," "Bullets," "Dolphins," "Hippos," "Snipes," "Hawks," "Elephants," "Squibs," "Kittens," "Babies," "Schneiders," "Bats," and others with fancy names coined affectionately for them by their designers and pilots, descend in the strictest genealogical tree from the original "Tabloid," so called because it contained so much concentrated excellence.

The 80-Avro of 1914

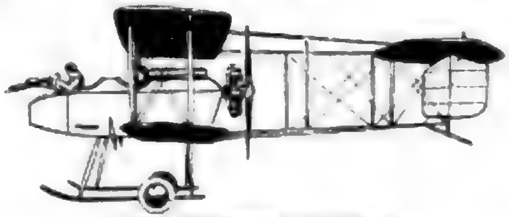
Following soon after the "Tabloid" came a new Avro, which remains today one of the most remarkable of airplanes. A large two-seater, with only an 80-hp. Gnôme, it put up a speed of well over 80 miles an hour. As a war machine early in the war it did excellently. Three bombed Friedrichshafen with success. Today, with but slightly higher power, it is the best of all training machines. Among two-seater biplanes it marked as great an advance as did the "Tabloid" among single seaters, and for the same reason. Careful lightening, without loss of strength, and careful stream-lining.



The 80-Avro, 1914

The Vickers Gun 'Bus of 1914

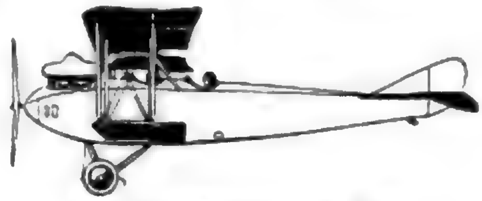
Also, early in 1914, came the first genuine gun-carrying biplane, designed and built by Vickers (Limited). Obviously of Farman inspiration, or descent, it had a specially strong nacelle, to stand the working of the gun. With a 100-hp. Gnôme, its speed was over 70 miles an hour. It was universally known as "The Gun 'Bus," and the name stuck to the whole class.



The Vickers Gun 'Bus

The Albatros Biplane of 1914

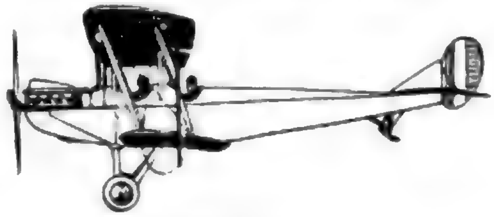
Another development of 1914 was the Albatros tractor biplane, with a six-cylinder vertical water-cooled Mercédès engine of 100 hp. This was the ancestor of all the big German tractor biplanes up to the present day. It, and they, are descendants obviously of the Bréguets and Avros of 1910.



The Albatros Biplane, 1914

The B. E. 2c of 1914

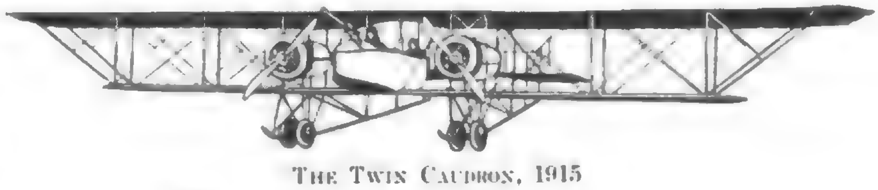
Just before the war the Royal Aircraft Factory produced an uncapsizable biplane nicknamed "Stability Jane." Her official title was the B. E. 2c, this being the third modification (c) of the second type of Mr. de Havilland's original B. E. When once off the ground the machine flew itself, and the pilot had only to keep it on its course. Though slow in speed and in maneuvering, the type was useful for certain definite purposes, and with further modifications it survives today, and does all that the Taube set out to do, with less waste of power.



The B. E. 2c.

The Twin Caudron of 1915

Though various experiments had been made with airplanes with more than one engine, and though many were designed in 1914 which afterwards made good, the first to fly regularly and with consistent success was the twin Caudron, with two 110-hp. Le Rhône engines. It may therefore claim to be the first twin-engined machine.



The Twin Caudron, 1915

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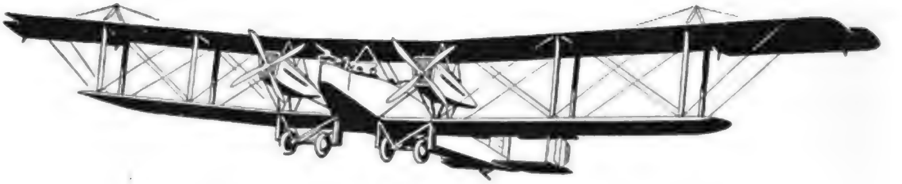
* Courtesy of the London *Times*.



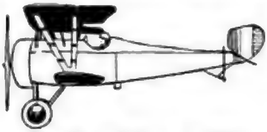
The Handley Page, 1916

The Handley Page Twin of 1916

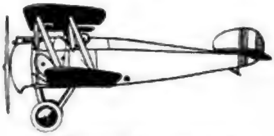
Closely following it came the huge Handley Page biplane of 1916, with (at first) two Rolls-Royce engines of 250 hp. each. Like everything else in the war, they have since gone up, and the power is now far higher. One of these machines in 1916 took a pilot and 20 passengers to a height of 7000 ft., and in 1917 another flew from London to Greece and then bombed Constantinople.

The 1916 Nieuport

The most noteworthy of the small machines of 1916 was the Nieuport biplane, with the 90-hp., and later the 110-hp., Le Rhône engine. This was an excellent fighting machine, and a direct successor of the "Tabloid." It was remarkable for the curious V formed by the struts between the wings.

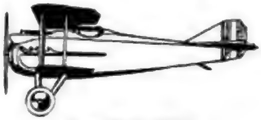


The Baby Nieuport, 1916

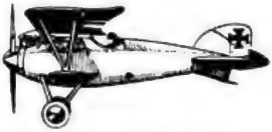


The Sopwith "Camel," 1917

Virtually there is only a single spar to the lower wings, so that it is more of a 1½-plane than a biplane. The Germans copied this single-spar idea in their Albatros single-seat "chasers" of 1917.



The Spad, 1917

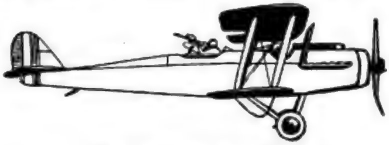


The Albatros III, 1917

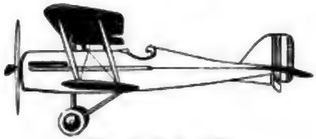
The Machines of 1917

The year 1917 is still too close for one to give many particulars about the outstanding features of its machines, but one may mention those which are known to be familiar to the enemy, and one may illustrate their outlines to show how they compare with the older types, and thus be enabled to note the line of development.

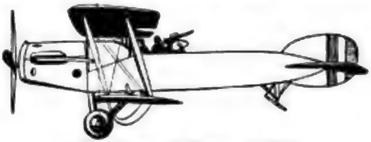
Here we have the Sopwith "Camel"; the Spad, designed by M. Béchereau, of Deperdussin fame; and the Albatros, D.iii type—all obviously descendants of the Nieuport and the Deperdussin, and the Tabloid. Also we have the de Havilland 4, built by the Aircraft Manufacturing Company (Ltd.), and designed by Captain de Havilland, as he now is; and we have the S.E.5, built and designed by his successors at the Royal Aircraft factory, both descendants of the B. E. Then there is the "Bristol Fighter," built by the British and Colonial Aeroplane Company, of Bristol, and designed by Captain Barnwell, a pioneer of flying in Scotland, who built a machine of his own in 1909. It shows traces of the 1910 tractor biplanes.



The De Haviland 4, 1917

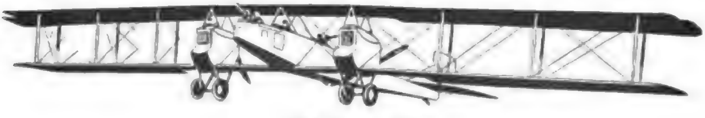


The S. E. 5, 1917



The Bristol Fighter, 1917

Finally we have the Gotha Bomber, of evil renown, a descendant of the Caudron and Handley Page twin-engined machines. Italy has produced the vast three-engined 1000-hp. Caproni triplane, but its sheer size prevents it from being illustrated to scale. And so we have in review practically all the salient steps in the development of the airplane from its earliest successful effort to its most modern types.



The Gotha, 1917

Some Problems of Airplane Design

By B. Russell Shaw

In this Era of Aviation when we are needing and building thousands of airplanes, there have come into the field many so-called airplane designers and aeronautical engineers. The experience of these men has been mostly perfunctory, if any, and they are constantly arriving at some conclusion or design which the past experience has proven inadequate or incapable of standing up under hard usage and actual flight conditions.

We require genuine aeronautical experts. Men who have made it a special study from the beginning of aviation. They may not be college graduates or masters at mathematics but should have sufficient knowledge to make all stress diagrams and performance charts. Above all, those who have gone through the building up of the industry are particularly fitted to act as practical builders and designers. It requires airplane men to construct this mighty fleet of airplanes; not men from different trades in the automotive industry.

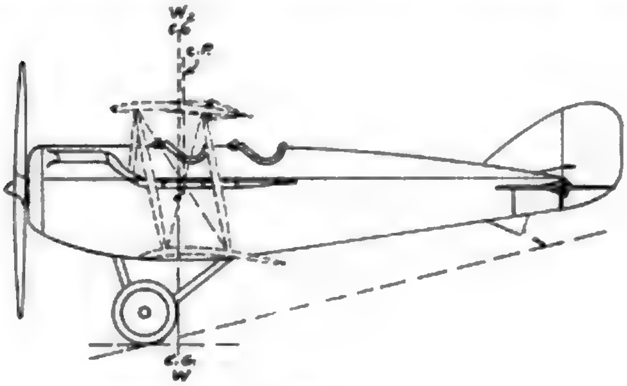


FIG. 1

Practically all the newcomers talk of is the factor of safety, and what after all is this thing? The incident of the famous St. Lawrence River bridge which had the very best engineering in the world figuring its strength, and yet collapsed twice, is proof of that old saying: "The so-called factor of safety is only a factor of ignorance." These methods are nevertheless the ones to be used now; but to prevent its being a factor of ignorance we must use fundamental factors of experience.

A few of the most common mistakes of these newcomers that have come to the writer's notice are the following:

A procedure often poorly followed in designing an airplane is the correct balancing of the component parts and giving them the correct relation with the center of pressure.

Some designers draw the complete machine, locate the center of pressure and center of gravity, then give them the correct relation by shifting such weights as the pilot and passenger or the gasoline tank. This method is very poor inasmuch as it does not allow the body struts and ties to be attached at the proper places. The gasoline tank should be given as nearly neutral position as possible, and not shifted.

The seats should not be moved, for once a proper and comfortable arrangement is reached that arrangement should remain as any moving from this point may cause cramping in an unnatural position. The body should be laid out complete, taking into consideration the range of vision of the pilot. If he is to be placed in front as in some European machines then the gunner in the rear seat must have ample room for action. It is sometimes an advantage to have two seats, one above the other so that the top one may be folded up allowing him to sit almost on the floor of the body for observation, camera work or bomb dropping, through a door in the floor.

The center of gravity of the entire body assembly is found by a very simple method shown in Fig. 3. The weights of the component parts are multiplied by their respective distances

$$AA_1 + BB_1 + CC_1 + DD_1 + EE_1 + FF_1 + GG_1, \text{etc.}, = \frac{W_1}{W}$$

The first distance A being anything desired. $W =$ the total weight of all component parts in the body assembly.

After this is done the wings should be considered. They should be drawn upon a separate sheet and the resulting C. P. and C. G. determined, allowance being made for the extra efficiency of the upper plane affecting the combined location of the C. P.

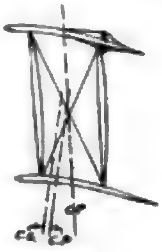


FIG. 2

The wings are then placed on the body and shifted until the desired relations of C. P. and C. G. are obtained. This will apply to a neutral tail setting. If a positive or negative tail is used, the forces actuated by it must be taken into account. The resulting forces caused by the leverage between the C. P. or K_y and the C. G. or W, as well as those between the lines of thrust and resistance, must be gone into very carefully when setting the tail plane so that the proper degree of longitudinal stability may be obtained.

There are several things to consider when placing the controls, of which a few are often slighted. They must, above all, be strong and well made. In the case where the stick is used with a universal at the lower end this should be wide enough to give plenty of leverage on the bearings; these should be bronze bushed and large enough to take the constant wear.

The rudder bar should be long so that ease of action may be attained, and also to allow plenty of leverage for a hard pull as in recovering from a spin. It is well to place small retainers projecting on each side of the foot-bar, to prevent slipping. These should be made integral with a foot corner plate to cover the edge of the bar and to take the wear, instead of the common practice in which the shoe wears away the wooden bar and makes a very shoddy-looking job. Allow plenty of bearing area in the bar, as this undergoes more wear and abuse than any other control. In case of a nose smash, the pilot is sure to brace himself against it and take most of the shock in this way.

Always place the controls in a comfortable position so the pilot in a long flight will not be cramped. The instrument board should not be placed so low that the pilot will strike it with his hands or knees.

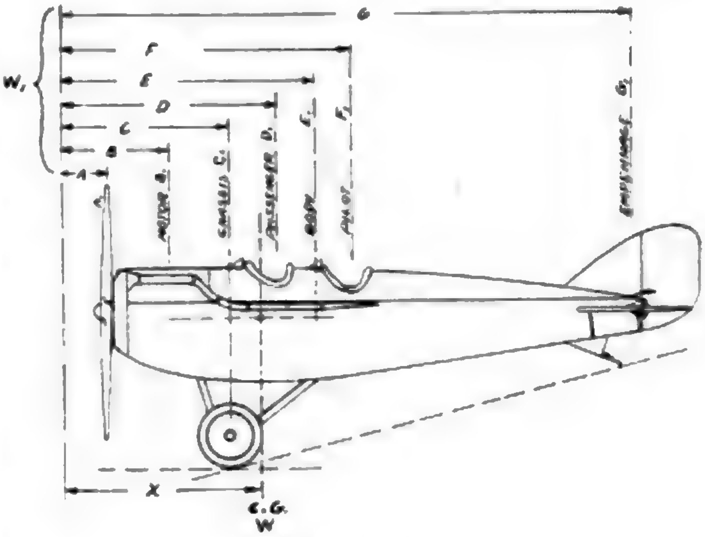


FIG. 3

In a number of European machines a small quadrant, with ratchet lock, is provided on the stick, that the pilot may have both hands free to make notes or "pull the gun." This is never done on training machines, for the pupil may lock the control and become confused, which may result in an accident. It is used only where real war work is to be done.

The spark and throttle controls must be in such position that they can be easily and quickly reached by a most natural

The Internal Combustion Turbine*

The advantages that would be derived from the development of the internal-combustion turbine for aircraft work can be appreciated from the fact that a purely rotary motion would then be available for these machines, and all reciprocating parts with their consequent vibration be eliminated. Many authorities consider that the next progress step will undoubtedly be on these lines, and it is generally considered that the practical limit of improvement in the thermal efficiencies of the present engines has now been reached. There is no doubt that in aero-engine design the stage has now been attained where no appreciable progress is to be expected with the existing types of engines, although minor improvements will naturally continue to be made, so further advancement with the motive power will become necessary to obtain better performances from aircraft.

The attractive possibilities of the gas turbine makes the development of this problem well worth investigating, and an account of the work done up to the present may perhaps be of interest. There is every reason to believe that the problem of designing a successful internal-combustion turbine is capable of a comparatively easy solution, and immense advantages will be obtained when this engine is a practical proposition. The turbine which was designed by M. René Armengaud was built in two sizes, one of which was constructed to have an output of 30 hp., and the other was expected to develop ten times this power.

Armengaud Principle

The 300-hp. Armengaud turbine developed practically the power for which it was designed, and both sizes of engines worked on the constant-pressure principle, the combustion of the mixture taking place continuously on its entrance into the combustion chamber. The fuel used during the tests was petrol, and electrical ignition was employed on these machines. Owing to the high temperature of the gases during combustion, the chamber was divided into two portions, the first being lined with carborundum, and the second was jacketed with a coil through which water flowed continuously. This has the effect of cooling the gases, and the water was admitted to the turbine in front of the nozzle when it was vaporized by the ignited gases and had a further cooling effect.

In these turbines the actual medium producing power therefore became a mixture of steam and gas, so that power was generated by this steam on a somewhat similar principle to that adopted in semi-Diesel engines using water injection. In this, as in all other gas turbines, the air had to be compressed in an external air-compressor before being admitted to the combustion chamber, which is one of the inherent defects of the principle of the internal-combustion turbine, especially if a reciprocating compressor be employed. With the 300-hp. Armengaud machine a compressor of the rotary type was adopted, coupled direct to the gas turbine, and the arrangement was fairly satisfactory, the air entering the combustion chamber at a pressure of about 100 lb.

Fuel

The Armengaud design of internal-combustion turbine could doubtless have been developed to employ heavy fuel oil, and although the results obtained from the engines apparently gave great promise, no work seems to have been recently carried out in improving or modifying this design. It is uncertain exactly what degree of economy was obtained with the turbine, but it is understood that the consumption was not reduced to nearly that of the present designs of reciprocating engines, which develop a horse-power with a heat expenditure of less than 10,000 British thermal units.

The Karovodine turbine was of the explosion type, and the method adopted showed great variation from the above design. A series of explosion chambers divided into two portions was employed, one portion of each chamber being vertically above the other, the lower being water-cooled and acting as a mixing chamber. The ignition plug was located in the upper part, and this portion was provided with an outlet for the exploded gases into the nozzle, and thence to the turbine blades. A mixture of air and gasoline passed from the bottom of the combustion chamber through a flap valve into the upper part, and this valve was held upon its seat by means of a spring, so that it could only be opened by pressure from beneath or suction above. After admission of the air and gasoline through the valve the mixture was exploded in the upper part of the combustion chamber, and from this the gases passed into the nozzle.

Combustion occurred in the top portions of the chamber, and after admission of the gases into the turbine there was a partial vacuum in these, the pressure being about 2 lb. below that of the atmosphere, and this was sufficient to cause the flap valve between the lower and upper parts of each chamber to open, so that air and gasoline were once more admitted into the combustion chamber. The charge was again ignited, and the cycle was continually repeated to obtain uniform rotation of the turbine. The results obtained from this machine were apparently quite good, but unfortunately they have not been followed up, and practically no commercial experience was obtained with the design.

The most important step in the direction of the development of a commercial internal-combustion turbine has been made by Mr. Hans Holzwarth, who has now built a machine with a designed output of 1,000 hp., and has made numerous tests upon it. This turbine embodies a totally different principle from those on which the two previous types were designed, although it is also an explosion turbine, and it may be mentioned that previous to constructing this large machine a small experimental one was built in 1908. The tests carried out on this engine were most instructive, and it was from the results of these tests that modifications were made in the larger machine, upon which a considerable number of important trials have been carried out by the inventor, which were most successful.

Holzwarth Turbine

The Holzwarth turbine has in many ways the most logical principle of operation which has yet been developed in any internal-combustion turbine, and the designer states that the following conditions are essential for a practicable machine: (1) Operation with periodical combustion, *i.e.*, the explosion type must be used as with reciprocating engines. (2) The space in which combustions takes place must be closed on the exhaust side leading to the actual turbine, at least during the greater portion of the charging with the combustible mixture. (3) The combustion chamber must be closed on the admission or charging side during the combustion and expansion period. (4) The combustion chamber must be scavenged with air during the interval between the individual explosions.

It is equally satisfactory for the closing arrangements to be on the exhaust or delivery side on a turbine complying with the above conditions and provided with a combustion chamber, or for the admission or charging side to be provided with mechanically operated valves which serve to deliver air into the combustion chamber. The Holzwarth turbines were of the vertical design, with the shaft arranged vertically, but the construction is equally applicable to machines of the ordinary design with horizontal shafts.

A series of combustion chambers are provided around the periphery of the machines, the number of these in the 1000-hp. turbine being ten, and they are arranged so that the explosion takes place in one combustion chamber after another around the whole circle. The oil fuel or gas is admitted to the combustion chamber, which at the time of the admission is full of air at a comparatively low pressure, it having been previously pumped into the combustion chamber and thence through the turbine at the end of the previous explosion in order to scavenge out and cool the machine thoroughly. After the admission of the gas the inlet valves are closed, and explosion is caused by means of an electric spark; a valve leading to the turbine nozzle is then forced open by the pressure, and the gases pass through to act on the vanes of the machine.

The gases acquire velocity in their passage through the nozzles, and then impinge on the vanes, which are of the ordinary impulse type with two rows of moving blades and one row of fixed blades. The nozzle valve is opened by the pressure due to the explosion, but is afterwards closed gradually by mechanical means, and during the period of closing more scavenging air enters the turbine under slight pressure, so as to clear out the products of combustion from the machine, leaving it full of fresh air ready for the admission of petrol or other fuel into the combustion chamber for another explosion.

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* Courtesy of *Flying* (London.)

Cooling

The air admitted to the machine also has the effect of maintaining the temperature at a reasonably low limit, and no water cooling was necessary, as no excessive heating of the blades was found to occur. The blades were constructed of nickel-steel, and as water was not formed during the process of combustion, no corrosion occurred throughout the long period through which the turbine was tested, also the blades gave no trouble. It was difficult to obtain the anticipated power out of the machine, and the consumption was not so satisfactory as had been anticipated; but many fuels were successfully employed, and it is interesting to note that heavy oil was utilized with success, a pulverizer of the Diesel type being adopted.

The experiments demonstrated that a high specific power could not be obtained from the combustion chambers when the number was relatively small, and that the efficiency of these chambers is lower when they are small than when of moderate size. This tends to indicate the difficulty of constructing a relatively low-powered gas turbine and the suitability of this type of engine for the largest outputs. It is, of course, apparent that there are no maximum limits of power with a turbine, as in a reciprocating engine, where the pressures on the piston cannot be allowed to reach a high figure. It was found that the design of the nozzles for gas could not be based on that of the ordinary steam turbine nozzles, and that the air-scavenging process between two explosions was necessary for reasonable efficiency with this cycle.

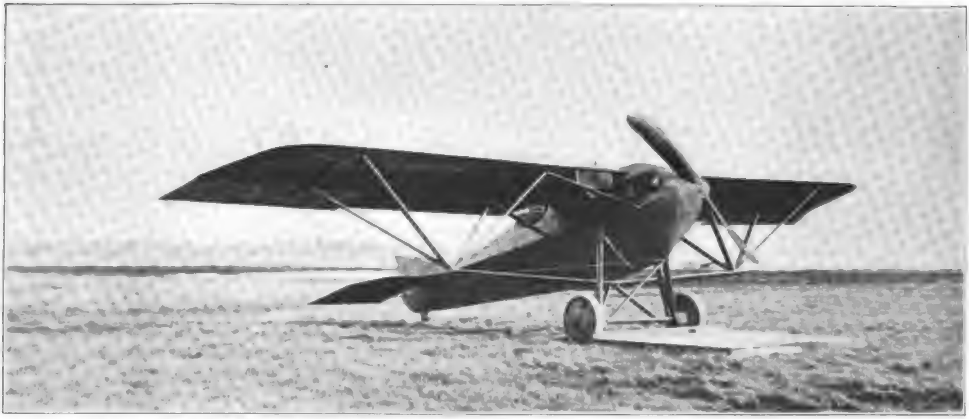
The scientific aspect of the design of the Holzwarth turbine is of great importance, and data of considerable value has been deduced from the results of the experiments on his machines. The temperature of the mixture before ignition has an important influence upon the efficiency of a gas turbine, and this should be approximately the same as that of the outside air; also many other important points in connection with the design of internal-combustion turbines were decided from the results of these experiments. No attempts was made to obtain an extremely light weight per horsepower, such as is necessary for aircraft work, as up to the present the experimenters have confined their attention to machines for industrial work.

An internal-combustion turbine proposed by Inrig which makes use of the steam both for purposes of scavenging and keeping the temperatures of the internal parts within reasonable limits has been built, and is intended mainly to employ heavy oils. This is of the horizontal design with an output of 30 hp., and the ordinary reaction blading with several rows of blades is employed. The machine is of the double flow type, and the admission takes place in the centre through one port, there being three valves, one each for air, oil, and water injection. The valves are of the piston type, and are operated by eccentrics mounted on a lay shaft driven from the main shaft through gearing.

The air compressor has to supply air at a high pressure in order to give a sufficiently high temperature to ensure combustion of the heavy fuel which is injected into the turbine immediately after the air. Directly the combustion commences, water is sprayed in, and, owing to the heat generated by the combustion of the fuel, is converted into steam. The ignited gas and steam then passes through nozzles on to the vanes of the turbine, in which they expand down to atmospheric pressure, and their energy becomes converted into work. There is no doubt that the problem of designing a commercially successful internal-combustion turbine will eventually be solved, and there appears to be no reason to anticipate that this type of engine cannot be applied successfully to aircraft.

American Naval Flying Boat Being Set Off Shore in France—This Machine, Which is Evidently of French Design, is Interesting on Account of Its Peculiar Truss and Also Because of the Construction of the Stern

(C) Kadel and Herbert



THREE-QUARTER FRONT VIEW OF THE STURTEVANT SCOUT

An American Pioneer Design

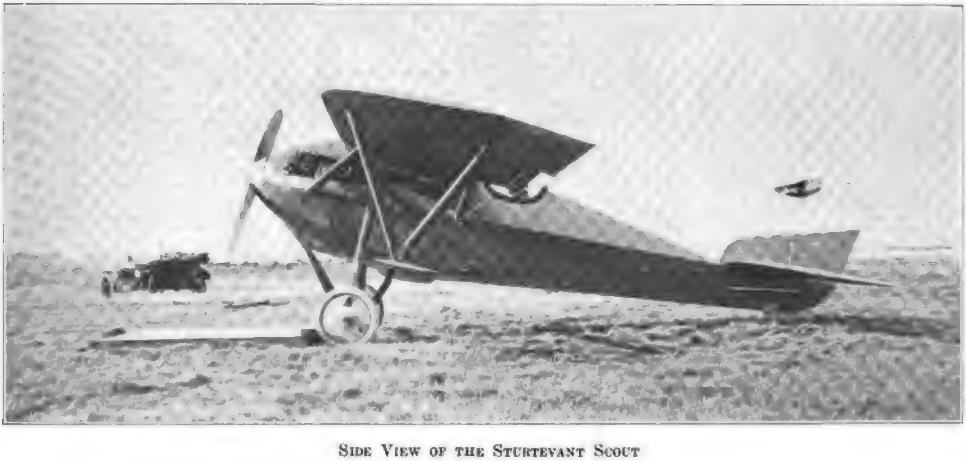
The contention is often made that the manifold difficulties attendant upon the creation of an American air fleet have to some extent been due to the lack of original thought in American airplane design. While this opinion was perhaps justified in some cases, it should nevertheless be considered that before this country entered the great war, there was no incentive, because of small Army and Navy appropriations and lack of sporting interest, to develop original types of machines.

That some American airplane designers were not, however, hopelessly outclassed in their ideas by foreign developments may be seen from the accompanying illustrations which represent a single seater scout designed and built in 1916 by Grover C. Loening, then chief engineer of the Sturtevant Aeroplane Co. of Boston, Mass., for the latter concern.

This machine was the outgrowth of a design originally developed in 1914 by Mr. Loening and Lieut. (now Col.) T. deW. Milling, U. S. A., at the Army flying school at San Diego, Cal. As may be seen, the machine embodied a number of features which are now currently found on the latest machines of the fighting type, but which were distinctly ahead of their time. One may thus note the pyramid truss, the "half-wing" feature created by the streamlining of the single lower spars, the careful cowling of the stationary engine and the use of overhead radiators set into the wings, both of which became recognized German features but a year later.

Particular attention was also paid in the design toward affording a wide range of view and facilities for the mounting of a machine gun, while the compactness of the general layout was quite notable. It should be noted that all structural parts of this machine were built of vanadium steel.

This machine was fitted with a 150 hp. Sturtevant engine of the 8-cylinder, water-cooled type and weighed, net, 1,000 lb. During 1916 it was frequently flown by Lieut. Milling and Bert Acosta, but the restricted nature of Squantum Field, where the trials took place, were such as to cause several crashes on landing. It was little realized at the time how typical these experiences were of what has been found in Europe in the development of new machines.



SIDE VIEW OF THE STURTEVANT SCOUT

International Aircraft Standards

(Continued from previous issues)

2V1—Specifications for Airplane Spar Varnish

General.—1. The general specifications 1G1 shall form, according to their applicability, a part of these specifications.

Composition and General Properties.—2. The material shall be the best long oil varnish, suitable for application on wood, "doped" linen or cotton, and metal, and must be resistant to air, light, water, and to washing with warm soap water. The manufacturer is given the greatest latitude in the selection of raw materials and in the process of manufacture in order to produce a product of the highest quality.

Physical Properties and Tests.—3. The material shall comply with the following requirements:

(*a*) It shall be clear and transparent.

(*b*) Its color shall not be darker than a standard color solution, made by dissolving 6 grams of pure powdered potassium bichromate in 100 cubic centimeters of pure concentrated sulphuric acid (specific gravity 1.84). Gentle heat may be used, if necessary, to secure a perfect solution of the bichromate. The color comparison will be made by placing the varnish and the standard color solution in clear, thin-walled glass tubes of the same diameter, 1.5 to 2 centimeters ($\frac{5}{8}$ to $\frac{13}{16}$ in.), to a depth of at least 2.5 centimeters (1 in.), and comparing the colors by looking through the tubes across the column of the liquid by transmitted light.

(*c*) It shall be below 35 deg. C. (95 deg. F.) in an open tester.

(*d*) The varnish shall be flowed on one side of a 10 by 15 centimeter (approximately 4 by 6 in.) panel of bright tin. The panels shall be approximately 0.3 to 0.4 millimeters (0.0125 to 0.0158 in.) thick (90 to 100 lb. weight of base metal per standard box of 112 sheets, 14 by 20 in., No. 30 to No. 28 U. S. standard plate gauge), and shall be cleaned thoroughly with benzol. When the panel is held in a vertical position and maintained at a temperature of 21 to 32 deg. C. (70 to 90 deg. F.), the varnish shall be set to touch at a point not less than 2.5 centimeters (1 in.) from the side of top edges of the film, in not more than 5 hr.; and shall dry hard in not more than 24 hr. to a clear, hard, glossy film. The panel shall then be allowed to dry for a further period of not less than 5 days and then be brought to a temperature of not less than 21 deg. C. (70 deg. F.) nor more than 24 deg. C. (75 deg. F.), and maintained at this temperature for not less than 15 min. The panel, with the varnished side on the outside, shall then rapidly be bent double over a rod 3 millimeters ($\frac{1}{8}$ in.) in diameter. The varnish film shall show no cracking or flaking at the point of bending.

(*e*) The varnish shall be applied to a basswood panel which has been filled with one coat of drop black in oil thinned with turpentine and drier, and allowed to dry for not less than 10 days before applying the varnish. It shall have suitable body to give proper brushing, flowing, and covering properties. The first coat of varnish shall be allowed to dry 48 hr., then lightly sandpapered, a second coat applied and allowed to dry 72 hr. The panel shall then be inclined at an angle of about 45 deg., and a gentle stream of cold tap water allowed to flow down the middle of the panel for 18 hr. After wiping off any deposits due to the tap water with a chamois skin, the varnish shall show no whitening, dulling, or other defects. A small stream of boiling distilled water shall then be allowed to flow down another portion of the panel for 20 min. The water shall be siphoned through a small glass tube, directly from a container in which it is boiling, onto the surface of the panel, in such a manner that there will be no appreciable lowering of the temperature of the water before it touches the varnish film. The siphon delivery tube shall be in a plane nearly parallel to the plane of the panel, so that the impact of the water will not tend to break the film. The varnish shall show no appreciable whitening and no more than a very slight dulling or other indications of marked deterioration, either when observed immediately after removing from the water or after drying for 2 hr.

[Note.—In general, results comparable to those given by the above method may be obtained by flowing one coat of varnish on duplicate panels of bright tin, thoroughly cleaned with benzol, allowing to dry 48 hours, and then immersing one of the panels in distilled water at room temperature for 18 hours and the other panel in boiling distilled water for 15 minutes. But the test on wood should be made in all cases when there is any doubt regarding the resistance of the varnish to water.]

(*f*) The varnish shall be applied in three coats to two unfilled panels of maple wood not less than 14 by 45 by 2 centimeters ($5\frac{1}{2}$ by 18 by $\frac{3}{4}$ in.), allowing 3 days for the drying of each coat. The first coat, after drying indoors for 3 days, shall be sandpapered lightly with No. 00 sandpaper before the application of the next coat. The second and third coats shall not be sandpapered or rubbed, and the duplicate panels shall be exposed outdoors, 45 deg. to the vertical, facing south, 3 days after the application of the finishing coat. The backs and edges of the panels shall also be varnished with three coats of the same sample, but for these surfaces the details of the method of application as given need not be adhered to, and the effects of exposure on these surfaces will not be considered. In the test, the varnish shall show satisfactory durability and weather-resisting properties. In cases when the award of a contract cannot be delayed for the results of the exposure test, award may be made on the basis of the other requirements, but a varnish of any specific brand which does not prove satisfactory in the exposure test may be omitted from consideration in future awards, and a preliminary submission of samples for making exposure tests may be called for.

2F1—Specifications for Mercerized Cotton Airplane Fabric (Grade A)

General.—1. The general specifications 1G1 shall form, according to their applicability, a part of these specifications.

Material.—2. (*a*) The warp and filling yarns used in the manufacture of this fabric must be size 2/60, according to the English cotton yarn numbers. A tolerance or plus or minus four (±4) will be allowed in the size of single yarns.

(*b*) The length of the staple of the fabric must not be less than $1\frac{1}{2}$ in.

Manufacture.—3. (*a*) The yarn shall be combed (single or double) and shall be mercerized under tension.

(*b*) It is recommended that the single yarn be given 28 to 34 turns per inch of twist and that 16 turns per inch be used for twisting these yarns together. This procedure may be altered provided that the fabric conforms to this specification in other respects.

(*c*) There must be at least 80 threads and not more than 84 threads per inch in both warp and filling.

(*d*) The weave shall be plain weave.

(*e*) The fabric must be uniform in structure and free from manufacturing imperfections.

(*f*) The fabric, under normal moisture conditions, must not weigh more than 4.5 oz. per sq. yd.

(*g*) The width must be 36 in.

Physical Properties and Tests.—4.—*Tensile Test.*—(*a*) The tensile test specimens, prepared in accordance with paragraphs 5(*a*), 5(*b*), 5(*c*), shall be exposed for at least two hours in an atmosphere of (5 per cent relative humidity at 70 deg. F. (21 deg. C.) and then tested in this atmosphere.

(*b*) The distance between the jaws or clamps of the testing machine at the beginning of the test shall be 8 in. (20 cm.). The pulling jaw shall move at the rate of 12 in. per min. during the test.

(*c*) The average breaking load of the five specimens cut in the direction of the warp and the average breaking load of the five specimens cut in the direction of the filling, as shown in Fig. 1, must each be at least 80 lb.

(*d*) The elongation shall be observed when the specimens are subjected to each of the loads given in Table 1.

(*e*) Whenever practicable, an autographic record shall be taken.

(*f*) The elongation must not exceed the values given in Table 1 by more than 10 per cent.

(*g*) The average results for both warp and filling shall be reported separately.

Table 1

Tension in Pounds.	Elongation in Inches, Warp.	Elongation in Inches, Filling.
10	0.65	0.32
20	.80	.40
70	1.20	.04

Test for Sizing.—(*h*) Tests for sizing shall be conducted as follows:

(1) Dry samples weighing approximately 0.18 ounce (5 gm.) in tared weighing bottles at 221 to 230 deg. F. (105 to 110 deg. C.) to constant weight.

(2) Boil the samples in water for 10 minutes and rinse thoroughly.

(3) Digest each sample in a solution containing 15 centimeters commercial diastofor in 500 centimeters water at 140 deg. F. (60 deg. C.) for two hours.

(4) Wash thoroughly in hot water and then boil for one hour in 500 centimeters distilled water and wash again.

(5) Dry in tared weighing bottles to constant weight.

(6) Percentage sizing =

$$\frac{\text{loss in weight}}{\text{original weight}} \times 100.$$

(*i*) The fabric must not contain more than 3.5 per cent of sizing, as determined by the above method.

Mercerization Test.—(*j*) Take approximately one-fourth square foot of the cloth, immerse in boiling distilled water and stir occasionally while cooling. At the end of 10 minutes place a strip of blue and a strip of red litmus paper into the liquid with the fabric and allow them to remain 5 minutes. At the end of this time the litmus papers must have retained their original colors. Any cloth showing either an acid or alkaline reaction shall be rejected. This test may be made on the yarn before weaving by substituting a small handful of the yarn for the cloth sample.

Selection of Test Specimens.—5. (*a*) Samples for tests shall be taken from at least five bolts in each warp woven.

(*b*) The sample taken from a bolt shall be 1 yard long and the full width of the bolt; it shall be cut from the fabric at a point 10 yards from the end of the bolt.

(*c*) Test specimens for tensile tests, 12 inches long and 1¼ inches wide, shall be cut from each sample taken as shown in Fig. 1. Threads shall be pulled out from the sides of the test specimens until a width of 1 inch of woven fabric remains.

Inspection and Rejection.—6. The inspector shall mark all accepted material close to the end of each bolt with the official acceptance stamp. Rejected material shall be marked with the rejection stamp and shall not be resubmitted without the express consent of the purchaser. The acceptance and rejection stamps shall be so placed that they do not injure the material, or, in the case of rejected fabric, so that the marking does not preclude the use of the material for other than aircraft work.

Replacements.—7. All fabric that does not conform to this specification shall be rejected and shall be replaced by the manufacturer at his expense.

2F2.—Specifications for Unmercerized Cotton Airplane Fabric (Grade A)

General.—1. The general specifications 1G1 shall form, according to their applicability, a part of these specifications.

Material.—2. (*a*) The warp and filling yarns used in the manufacture of this fabric must be size 2/60, according to the English cotton-yarn numbers. A tolerance of plus or minus four (±4) will be allowed in the size of single yarns.

(*b*) The length of the staple of the fabric must not be less than 1½ inches.

Manufacture.—3. (*a*) The yarn shall be combed (single or double).

(*b*) It is recommended that the single yarn be given 22 to 25 turns per inch of twist and that 25 to 26 turns per inch be used for twisting this yarn together. This procedure may be altered provided that the fabric conforms to this specification in other respects.

(*c*) There must be at least 93 threads per inch in warp and 86 threads per inch in filling. A tolerance of plus or minus two (±2) threads will be allowed.

(*d*) The weave shall be a plain weave.

(*e*) The fabric must be uniform in structure and free from manufacturing imperfections.

(*f*) The fabric, under normal moisture conditions, must not weigh more than 4.5 ounces per square yard.

(*g*) The width must be 36 inches.

Physical Properties and Tests.—4. *Tensile Test.*—(*a*) The tensile test specimens, prepared in accordance with paragraphs 5 (*a*), 5 (*b*), and 5 (*c*), shall be exposed at least two hours in an atmosphere of 65 per cent relative humidity at 70 deg. F (21 deg. C.) and then tested in this atmosphere.

(*b*) The distance between the jaws or clamps of the testing machine at the beginning of the test shall be 8 inches (20 cm.). The pulling jaw shall move at the rate of 12 inches (30 cm.) per minute during the test.

(*c*) The average breaking load of the five specimens cut in the direction of the warp and the average breaking load of the five specimens cut in the direction of the filling, as shown in Fig. 1, must each be at least 75 pounds.

(*d*) The elongation shall be observed when the specimens are subjected to each of the loads given in Table 1.

(*e*) Whenever practicable an autographic record shall be taken.

(*f*) The elongation must not exceed the values given in Table 1 by more than 10 per cent.

(*g*) The average results for both warp and filling shall be reported separately.

Table 1

Tension in Pounds.	Elongation in Inches, Warp.	Elongation in Inches, Filling.
10	0.74	0.42
20	.94	.53
70	1.44	.90

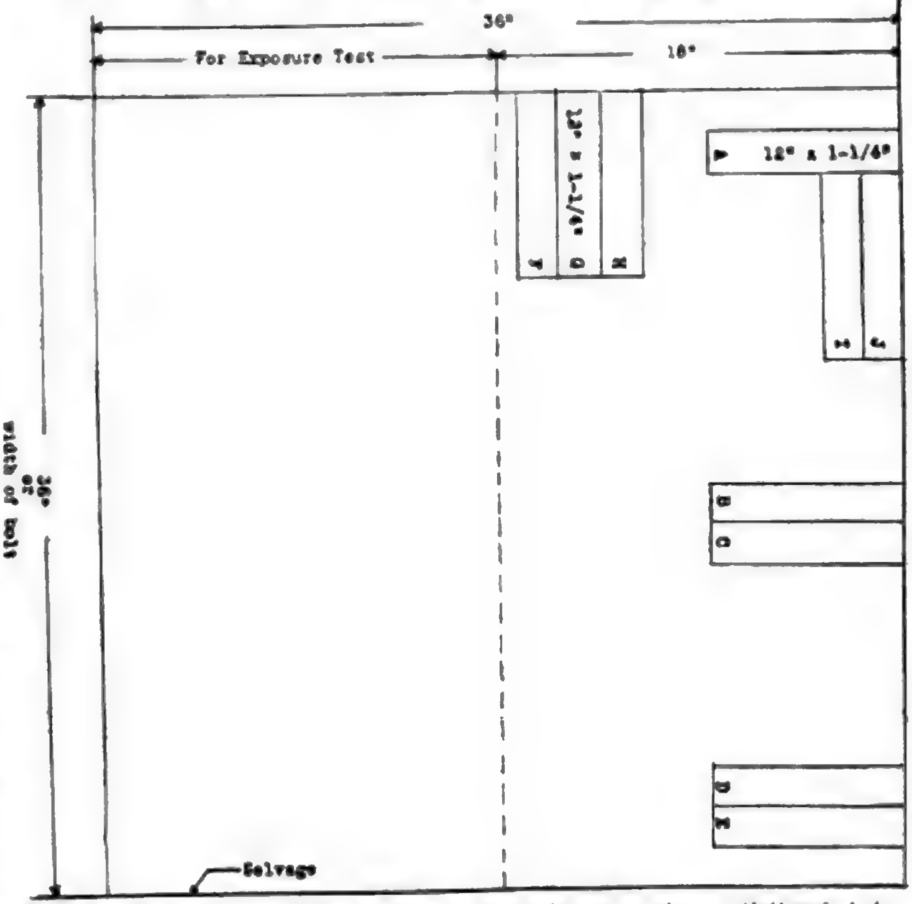


Fig. 1.—*Sketch showing the location of the 10 test specimens (lettered A to F) to be cut from the sample.*

Test for Sizing.—(*h*) Tests for sizing shall be conducted as follows:

(1) Dry samples weighing approximately 0.17 ounce (5 gm.) in tared weighing bottles at 221 to 230 deg. F. (105 to 110 deg. C.) to constant weight.

(2) Boil the samples in water for 10 minutes and rinse thoroughly.

(3) Digest each sample in a solution containing 15 cubic centimeters commercial diastafor in 500 cubic centimeters water at 140 deg. F. (60 deg. C.) for two hours.

(4) Wash thoroughly in hot water and then boil for one hour in 500 cubic centimeters distilled water and wash again.

(5) Dry in tared weighing bottles to constant weight.

(6) Percentage sizing $= \frac{\text{loss in weight}}{\text{original weight}} \times 100.$

(*i*) The fabric must not contain more than 3.5 per cent of sizing, as determined by the above method.

Selection of Test Specimens.—5. (*a*) Samples for tests shall be taken from at least five bolts in each warp woven.

(*b*) The sample taken from a bolt shall be 1 yard long and the full width of the bolt; it shall be cut from the fabric at a point 10 yards from the end of the bolt.

(*c*) Test specimens for tensile tests, 12 inches long and 1¼ inches wide, shall be cut from each sample taken as shown in Fig 1. Threads shall be pulled out from the sides of the test specimens until a width of 1 inch of woven fabric remains.

Inspection and Rejection.—6. The inspector shall mark all accepted material close to the end of each bolt with the official acceptance stamp. Rejected material shall be marked with the rejection stamp and shall not be resubmitted without the express consent of the purchaser. The acceptance and rejection stamps shall be so placed that they do not injure the material, or, in the case of rejected fabric, so that the marking does not preclude the use of the material for other than aircraft work.

Replacements.—7. All fabric that does not conform to this specification shall be rejected and shall be replaced by the manufacturer at his expense.

2F3.—Specifications for Mercerized Cotton Airplane Fabric (Grade B)

General.—1. (*a*) The general specifications 1G1 shall form, according to their applicability, a part of these specifications.

Material.—2. The warp and filling yarns used in the manufacture of this fabric must be size 3/80, according to the English cotton yarn numbers. A tolerance of plus or minus four (±4) will be allowed in the size of single yarns.

(*b*) The length of the staple of the fabric must not be less than 1½ inches.

Manufacture.—3. (*a*) The yarn shall be combed (single or double) and shall be mercerized under tension.

(*b*) It is recommended that the single yarn be given 36 to 40 turns per inch of twist and that 18 to 20 turns per inch be used for twisting these yarns together. This procedure may be altered, provided that the fabric conforms to this specification in other respects.

(*c*) There must be at least 68 threads and not more than 72 threads per inch in both warp and filling.

The Aircraft Situation

Very little as to the plans of the War Department has been made known since the appointment of John D. Ryan as Director of Aircraft and of Gen. William L. Kenly as chief of the Division of Military Aeronautics, Aviation Section, Signal Corps. While plans are under way for reorganization of the Air Service, it is believed that no radical changes will be made until empowering legislation is secured. This legislation may be in the form of a special law, but probably the Overman bill when passed will serve as authority for the changes the President will make. It is thought this bill, which has passed the Senate and been reported to the House without change, will soon become a law. Under it the President will be empowered to make practically any changes he desires without other Congressional sanction.

No accurate forecast of the reorganization plans is possible. It is deemed certain, however, that the Aviation Section will be completely divorced from the Signal Corps. Whether it will remain under the direction of the Secretary of War, or joined with the Naval Flying Corps and administered by a new cabinet officer, is a matter of conjecture—but the impression that the Air Service will become a separate service is growing among those who usually are well informed.

It is understood that General Kenly's idea is to have a new organization to be known as the Air Service, which is the term now used by the American Expeditionary Force. This plan is said to contemplate the creation of three divisions of the Air Service at the head of which will be Mr. Ryan. One of these is the Division of Military Aeronautics, of which General Kenly is the head; a second, the Production Division, of which as head of the present Equipment Division W. C. Potter will be chief, and the third a Technical Division, the scope and the relation of which to the other two divisions, in charge of another man, is to be worked out.

Mr. Potter is very busy with his part in the plans of reorganization in addition to his regular duties. Several of the Departments of the Equipment Division have already been removed to new quarters to make more room for others at 119 D Street, N. E. These include the Lubrication Department, which is now located at 1335 F Street, N. W., and the Motor Transportation and Supply Departments, the Signal Material and Export Sections and the office of Colonel Waldron, which are now at 635 F Street, N. W. It is reported that the office of Mr. Potter may soon be located in the Munsey Building, where the Aircraft Board now is.

At least one notable change has occurred in the personnel of the Equipment Division. Reference is made to the resignation by Maj. Harry L. Shepler of his commission in the Army, and its acceptance by the President to date from April 29 Major Shepler had been in charge of the plane production section. What this signifies is not revealed.

The Aircraft Board

John D. Ryan, the director of Aircraft, is also chairman of the Aircraft Board in place of Howard E. Coffin, resigned. While rumors are current that all of the members of the Board have handed in their resignations, no verification of this can be secured. It is known, however, that Harry B. Thayer, who has been on the Board since March 1, is out. Under the law creating the Board provision is made that the Chief Signal Officer of the Army and the Chief Constructor of the Navy shall be members of the Board. Therefore it would appear that Maj. Gen. G. O. Squier and Rear Admiral D. W. Taylor could not resign should they desire to do so.

Nominations Confirmed

The nomination by the President of "John D. Ryan of Montana to be chairman of the Aircraft Board," and the appointment of "Brig.-Gen. William L. Kenly, National Army, to be major general with rank from April 29, 1918," were received by the Senate on May 3, and have been confirmed.

Investigations

Many views on the aircraft situation have been expressed in the House of Representatives during the past fortnight, and frequent references was made to the report given to the President by Gutzon Borglum, the sculptor.

The demand for an investigation of the allegations of graft was heeded on May 6 by the President who decided to turn the whole matter over to Attorney General Gregory, who was instructed to make a thorough investigation of the "wholesale charges" in regard to the production of aircraft made by Borglum.

The President's decision in favor of an investigation was announced after he had received from Howard E. Coffin, late chairman of the Aircraft Board, who had been South, a telegram urging that an official inquiry be made "in order that the reputations of innocent men may not be ruined."

The announcement of the President's decision was made when the White House gave out copies of messages exchanged between President Wilson and Howard E. Coffin and a copy of a letter sent by President Wilson to Senator Thomas of the Military Affairs Committee, in which the President expressed the hope that "the matter will be treated as one for searching official investigation by the constituted authorities of the Government" and said that "every instrumentality at the disposal of the Department of Justice will be used to investigate and pursue charges of dishonesty or malversation of any kind."

The President also made public seven letters he had sent to Mr. Borglum or Secretary of War Baker in the last five months in connection with the investigation the sculptor was making into the aircraft production situation. These show that the President in January urged Mr. Borglum to come to Washington, lay the whole matter frankly and fully before Secretary Baker, "and by your own investigation discover the facts in this business," but in April wrote him that "I never at any time constituted you an official investigator."

Attorney General Gregory has placed Assistant Attorney General Frierson of the Department of Justice in direct charge of the investigation, and it is said that he immediately began the study of the reports that have been submitted by Gutzon Borglum, the special committee headed by H. Snowden Marshall and the Senate Committee on Military Affairs. While Mr. Frierson has not yet had an opportunity to examine any witnesses, it is thought that he will do so without delay.

The Senate to Investigate

On May 8, Senator Chamberlain, chairman of the Committee on Military Affairs, introduced a resolution calling for an investigation of the aircraft situation by the Committee on Military Affairs or by a sub-committee of that body, authorizing and directing it "to inquire into and report to the Senate the progress of aircraft production in the United States, or any other matter relating to the conduct of the war by or through the War Department."

It is understood that Senator Chamberlain's idea is to make a most thorough investigation of the entire aircraft situation and to examine many witnesses who have first-hand knowledge of conditions.

Court of Inquiry Requested

Another feature was added to the case when it became known that Major-General Squier, Chief Signal Officer; Col. E. A. Deeds and Col. R. L. Montgomery, the Army's representatives on the Aircraft Board, have requested the appointment of a court of inquiry to examine into their conduct. Secretary Baker has announced that he will hold these requests in abeyance, because he believes a third examination of the same set of facts at the same time might confuse, if not delay, the inquiry. Therefore the military court is not likely to be assembled until the other investigations have been concluded.

Borglum's Reported Interests

According to press reports documents from the official files of the government have been made available for the use of the Senate which are alleged to show that Borglum, whose charges against the airplane program constituted one of the direct causes leading up to the airplane inquiries, has been connected with negotiations for the establishment of a new aircraft corporation in which he was to have been a silent partner.

It is stated that interesting correspondence and affidavits will be read into the *Congressional Record*, and that these documents will also be used in questioning the sculptor when he is called before the sub-committee of the Committee on Military Affairs which will conduct the inquiry into the entire aircraft situation.

News of the Fortnight

Army to Examine All Inventions

What will be welcome news to the thousands of inventors, who have endeavored in vain to have their ideas considered by the War and Navy Departments, is that an Inventions Section has been established at the Army War College, Washington, D. C., and that a staff of experts will be in session there daily to consider and pass upon the merits of inventions of a military nature which are of possible value to the Army.

Knowledge of the creation of the new section has not at this writing been made public through the usual channels, but it comes to AVIATION AND AERONAUTICAL ENGINEERING upon such reliable authority that it may be said to be official. We quote as follows from a document dated April 16:

"An agency has been created within the General Staff of the Army for the primary consideration of all inventions, and suggested ideas of inventions, whether patented or not, of a military nature, pertaining to the Army, and which the inventor desires to submit to the Government for inspection, test, development, or with a view to its purchase or use. It is requested that should applications of this nature be received in any of the offices of your department, the same be sent informally and directly to the Inventions Section, General Staff, Army War College, Washington, D. C. Applications made in person by inventors should be referred to the same agency and address."

It is estimated that there are approximately 4,500 inventors who either have been unable to get in touch with the chiefs of these two departments or with the heads of bureaus upon the ground that their time is so taken up with other matters that they have none to spare for such things. Some of these ideas are in various stages of progress. Many of the inventors have been at the capital for months without having been able to secure any action so that it is easily believable that not a few of them had become so discouraged as to wonder whether they would ever get an audience, or would ever learn whether from the Government's standpoint their inventions are good, bad or indifferent. The majority of them came from long distances and by reason of the protracted delays and official inaction have been put to unusual, unexpected and extraordinary expense, which the most of them can ill afford.

Refused a reception and buffeted from pillar to post, they sought a way out of these very unsatisfactory conditions and that agitation resulted this month in a few of them getting together and forming the American Inventors' Association, one of whose principal objectives is to secure the creation of just such a bureau as the Secretary of War has now taken the first steps to establish for his department. Should the Secretary of the Navy take similar action, and it is thought that he probably will, the hitherto existing conditions, of which men with inventions have generally and justly complained should be materially, if not entirely relieved, and it is thought information as to whether inventions are available for Government use will be given with the minimum of delay.

Aerial Mail Starts May 15

The Post Office Department announced that the airplane mail service between Washington, Philadelphia and New York will be started May 15. Military airplanes for the service have been assembled at Mineola, N. Y.

As experiments will be made in dropping mail sacks while the airplanes are in flight, mail for the present will be confined to letters, but later sealed parcels will be accepted.

During the early stages of the service no attempt will be made to dispatch airplanes on days when rain and fog will obstruct the vision of the aviator. On such days the mail will be dispatched by courier on trains and given special delivery service.

The Senate has passed a bill establishing a rate of 24 cents an ounce or a fraction thereof. The bill has gone to the House.

New Aircraft Company Formed

The Carolina Aircraft Co. has been organized at Raleigh, N. C., with an authorized capital of $500,000, of which $20,000 has been paid in. The stockholders are Harry N. Atwood, Howard White, John A. Park, and J. M. Broughton. The first airplane is to be completed in sixty days.

Application for Flying Permits

In paragraphs 1 and 2 of the Presidential proclamation of Feb. 28 last in regard to licenses for civilian fliers are given some of the details which an applicant must set forth in his application. Further information as to these requirements is indicated in the blank form of application furnished by the Joint Army and Navy Board on Aeronautic Cognizance and of which the following is a copy:

APPLICATION FOR LICENSE

License for making flights in civilian aircraft is desired under the following terms and conditions:

(Make separate application for each aircraft.)

License to be issued to:

Name ....
Address ....
Description of aircraft..
....
Owner ....
Address ....
To be operated by..
Address ....

If passengers to be carried, give names and addresses:

Name.......................... *Address*..........................
Name.......................... *Address*..........................
Name.......................... *Address*..........................
Territory in which flights are to be made..................................
....
Purpose for which flights are to be made..................................
....
License to be valid from.......................*to*.......................
Date *Date*

Names and addresses of four references to whom applicant is well known:

Name.......................... *Address*..........................
Name.......................... *Address*..........................
Name.......................... *Address*..........................
Name.......................... *Address*..........................

Signature of applicant:

Name ....
Address ....
Date ....

This application after being properly executed should be sent to

THE JOINT ARMY AND NAVY BOARD ON AERONAUTIC COGNIZANCE,
1607 *H Street, N. W., Washington, D. C.*

While the recent decision of the Board to the effect that no more licenses will be issued to civilians, as has been noted in AVIATION AND AERONAUTICAL ENGINEERING, has been disastrous to the business of private flying schools, manufacturers of planes for private use and others along those lines, modifications of it have been or may be made under certain circumstances.

One of these is that a license may be granted if it is shown that it will be for the public good. An instance of this is the case of Miss Ruth Law, who gave a demonstration with a Curtiss plane of the pusher type during the Liberty Loan parade in Washington, D. C., last week. An application for her to fly was made by and granted to the local Liberty Loan Committee for the reason indicated.

Again, the ruling may be liberally interpreted if the application shows that the purpose of the flight is for testing out a machine designed for war work. Hence, a manufacturer or inventor who wishes to test a plane which may be available for the United States Army or Navy will stand a very good chance of securing a license, even though at the time he has no Government contract.

Stops Patents to Enemies

President Wilson on April 16 stopped the issuance of patents and copyrights to enemies and revoked the authority given Americans to apply for patents in enemy countries.

By executive order the President revoked authority previously vested in the Secretary of the Treasury to issue licenses to enemies to take out of the country papers, pictures or communications relating to letters patent, copyrights or registration of trade marks. At the same time the Federal Trade Commission was prohibited from granting licenses to American citizens to prosecute patent applications in enemy countries.

Major Shepler Resigns from Army

The President has received and accepted the resignation of Major Harry J. Shepler as an officer in the Army. Major Shepler was chairman of the Plane Production Section of the Production Department, Signal Corps, and continued in that position after a Western office was opened and a large part of the personnel was removed to the Union Building, Cleveland, Ohio. The resignation took effect on April 29.

War Service Bureau for Congress

A Congressional Army War Service Bureau is proposed in a bill (H. R. 11894) introduced in the House on May 3 by Representative Sanford of New York. The bill which was sent to the Committee on Military Affairs, is as follows:

"That to promote more efficient cooperation and coordination between Members of the two Houses of Congress and the various branches of the War Department and of the United States Army, there is hereby established a bureau to be known as the Congressional Army War Service Bureau, to which shall be referred for prompt consideration and decision all correspondence received by Members of Congress relating to appointments, commissions, promotions, transfers, assignments, and general disposition of officers and enlisted men of the United States Army. That there shall be in such bureau a Division of Senate Correspondence and a Division of House of Representatives Correspondence in charge of a director, respectively, each of whom shall be detailed by the Secretary of War from the active or retired list of the Army to serve without additional compensation.

"Sec. 2. That the bureau and its divisions shall have such deputies, assistants, clerks, and other employees as may be from time to time provided by Congress. The bureau shall, by and under the direction of the Secretary of War, make use of employees of the War Department and of officers and enlisted men of the Army on the active or retired list to such extent as may be necessary for the proper and expeditious transaction of its business.

"Sec. 3. That the Secretary of War shall submit annually estimates of the appropriations necessary for the work of the bureau.

"Sec. 4. That for the purpose of carrying out the provisions of this Act, there is hereby appropriated, out of any moneys in the Treasury not otherwise appropriated, the sum of $100,000, or so much thereof as may be necessary, for the payment of all expenses incident to the work authorized under this Act, including salaries of all employees other than those detailed from the War Department and from the Army, employed in the District of Columbia and elsewhere, as the Secretary of War may deem necessary, rent and equipment of offices, typewriters and exchange of same, and all other necessary expenses: *Provided*, That the use of unassigned or unoccupied portions of the Senate and House Office Buildings, respectively, is thereby authorized to the extent that may be necessary for the temporary accommodation of the bureau.

"Sec. 5. That all officers and employees of the bureau not detailed from the War Department or from the Army shall be appointed from lists of eligibles to be supplied by the Civil Service Commission and in accordance with the civil-service law; salaries shall be the same as are paid for similar services in other departments of the Government.

"Sec. 6. That it shall be the duty of the directors of the Congressional Army War Service Bureau, under such rules and regulations as the Secretary of War shall prescribe, to receive and promptly dispatch replies to letters, telegrams, and other forms of correspondence addressed to Senators and Representatives in Congress, and to Delegates and Resident Commissioners, relating to the personnel of the Army, and to furnish information concerning the same in accordance with the Army regulations, military orders, and general orders of the Secretary of War. But no recommendation of any person who shall apply for appointment, commission, promotion, transfer, or assignment, in the military service of the United States, which may be given by any Senator, Member of the House of Representatives, Delegate, or Resident Commissioner, except as to the character and residence of the applicant, shall be received or considered by any official or employee of the War Department or of the bureau created by this Act or by any officer of the United States Army."

Alexandria Aircraft Corp.

The Briggs Aeroplane Co., of Alexandria, Va., will be known after May 15 as the Alexandria Aircraft Corporation. Blaine Elkins continues as president, while A. W. Briggs, general manager, retires to engage in other business.

Aircraft Workers Buy Bonds

The employes of the Wright-Martin Aircraft Corp., New Brunswick, N. J., subscribed over $500,000 for the Third Liberty Loan.

Magneto Plants Seized by U. S.

The Bosch Magneto Company's plants at Plainfield, N. J., and Springfield, Mass., were recently taken over by the Alien Property Custodian. The company manufactures magnetos for airplanes, automobiles, trucks and other Army and Navy equipment. The estimated value of the property is about $5,000,000, with a capital stock of $25,000.

Custodian Palmer's announcement on assuming control of the plant said:

"Prior to the entrance of the United States into the war this company had refused to take orders from the Allies, and after the United States went in it was loath to render any service to the Government in its activities against the Fatherland. The directors to be appointed by the Alien Property Custodian will immediately take charge of the works. They will be operated in full by the United States and the entire product be placed at the disposal of the munitions committees. As this is one of the best equipped plants in the country, its output will be of inestimable value to both the Army and Navy.

"After the examination conducted by Francis P. Garvan, director of the Bureau of Investigation, and examination which is tracing the ownership of many properties in various parts of the country, all the capital stock of the Bosch Magneto Company has been proven to be owned by Robert Bosch and other residents of Germany. When first reported by Carl Schurz, of New York City, as president, in December, 1917, he claimed that all but a small proportion was owned by residents of this country.

"At the time of the declaration of war Otto Heins, who was then president, and many of the German heads of departments walked out of the mill with the purpose that this concern should not be used in making war upon Germany. The present directors are Carl Schurz and Gustav Jahn. These directors will be replaced by directors designated by the Alien Property Custodian."

Naval Fliers to Make Frequent Flights

On March 14 the Secretary signed a General Order, amending General Order No. 205, dated April 12, 1916, and requiring flying under flight orders. This order, which was not issued until last Saturday, reads as follows:

"1. All Naval personnel detailed for duty involving actual flying in aircraft shall, while so detailed, make flights in such frequency that at no time shall more than one calendar month intervene between flights.

"2. In any case where more than one calendar month shall have intervened without a flight being made, flight orders will be held as in abeyance after the expiration of the first successive calendar month and will continue to be held in abeyance until the first of the succeeding month in which a flight is made. The receipt of increase in pay and allowances for duty involving flying will be prohibited during the period in which the flight orders are in abeyance.

"3. In the case of individuals failing to perform a flight because of physical disability incident to flying, flight orders during the period of such disability will be considered as fully in effect."

Anti-Aircraft Gun Trailers

In a description of motor vehicles, etc., made by the Ordnance Bureau, War Department, are given the following data of two anti-aircraft gun trailers for the U. S. Army:

The one and a half-ton anti-aircraft trailer is supplied to transport the 75 mm. improvised anti-aircraft gun. Two trailers are used to transport each piece, one carrying the gun and cradle, and the other the gun platform.

The three-ton anti-aircraft gun trailer, weighing about 4200 lb., is designed to have permanently mounted upon it a 75 mm. anti-aircraft gun. This trailer also carries a box containing ammunition.

General Aeroplane Co. Discontinues Business

The General Aeroplane Co., formerly manufacturers of aircraft at Detroit, Mich., has discontinued operations.

Standard Screw Co. Changes Name

The Standard Screw Company of Pennsylvania, Corry, Pa., have recently changed their name to the Standard Turnbuckle Company.

"A Great Net of Mercy Drawn Through
an Ocean of Unspeakable Pain"

What Your Red Cross Dollars Do

An accounting of Expenditures of the First Red Cross War Fund

Every one of the twenty million and more Red Cross members is entitled to this statement. Your local Red Cross Chapter can give you further details.

First War Fund Appropriations up to March 1st, 1918

Foreign Relief:	
Relief in France	$30,936,103.04
Relief in Belgium	2,086,131.00
Relief in Russia	1,243,845.07
Relief in Roumania	2,676,368.76
Relief in Italy	3,588,826.00
Relief in Serbia	875,180.76
Relief in Great Britain	1,885,750.75
Relief in other Foreign Countries	3,576,300.00
Relief for Prisoners, etc	343,304.00
Equipment and expenses in U. S. of Personnel for Europe	113,800.00
Total Foreign Relief	$47,325,609.38
Restricted as to use by Donor	2,520,409.57

United States Relief:	
U. S. Army Base Hospitals	$ 54,000.00
U. S. Navy Base Hospitals	32,000.00
U. S. Medical and Hospital Work	531,000.00
U. S. Sanitary Service	403,000.00
U. S. Camp Service	6,451,150.86
U. S. Miscellaneous	1,118,748.41
Total U. S. Relief	$8,589,899.27
Working capital for purchase of supplies for resale to Chapters or for shipment abroad	15,000,000.00
Working cash advances for France and United States	4,286,000.00
Total of War Fund Appropriations	$77,721,918.22

At the close of the first year of the War the Red Cross goes to the public for the raising of the Second War Fund with a record of appropriations which warrants continued contribution to this great relief work. As an influential citizen of your community, join with your local Red Cross Chapter to make this campaign successful. Your Red Cross is the Army behind the Army. Give till your heart says stop.

Second Red Cross War Fund Week May 20-27

This space contributed to the Winning of the War by
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JUNE 1, 1918

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Air Propulsion*

By Morgan Brooks

Professor of Electrical Engineering, University of Illinois

This paper describes experiments with propellers, asserting that the accepted screw theory of air propulsion does not accord with the facts. Air is impelled by a propeller at a speed approaching twice the screw advance for small blade angles, hence the theory of reflection or batting action should replace the screw theory. Thrust is shown to be due in greater degree to velocity and less to blade disk area than is commonly supposed. A method of predicting the complete flying performance of a propeller from a single static test of an accurate model is indicated.

The term airscrew, considered by many writers on aeronautics as descriptive of propeller action, is a misnomer. The theory of the marine propeller, which seems to be adequately presented by the screw principle, has been transferred to air propulsion without sufficient regard for the extreme difference in the two fluids as to elasticity. Imagine automobile tires filled with water. In view of the current theory that air is driven by a propeller with a velocity never exceeding the product of the propeller's pitch and its revolution, it was a surprise to find that air may be driven backward at a velocity nearly twice as great as this product indicates. The fact was so revolutionary as to cause the greatest care in measurement before its acceptance. Recognition of this superspeed action of propellers explains many anomalies of air propulsion and will undoubtedly lead to more exact formulas for thrust and power calculations.

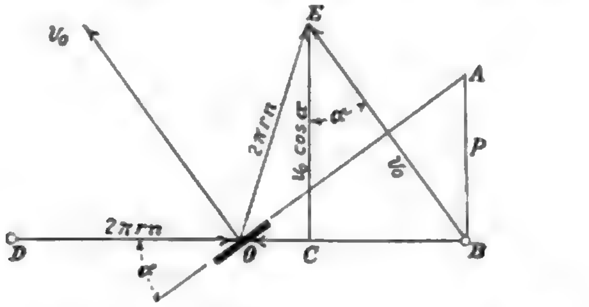

FIG. 1. DIAGRAM ILLUSTRATING TEST CONDITIONS FOR A WIDE-BLADE PROPELLER HAVING A BLADE ANGLE (α) OF 36 DEGREES

The purpose of this paper is to give proofs of the facts stated, and to point out some of the applications of the superspeed theory as it relates to propellers and blowers.

Superspeed is not observed readily in connection with the standard type of two-bladed propeller, owing to the masking of the effect by the mingling of high-speed air with a much larger quantity of inert air lying between the propeller blades. The measurements were made upon a special type of propeller having extremely short blades of great width, sweeping the entire 360 deg. of the disk area, in fact. It should, perhaps, be stated that with the acceptance of superspeed the definition of slip as "the backward velocity of the current from a propeller" must be abandoned; but another definition of slip, "the shortage of velocity of translation as percentage of propeller screw advance," may survive owing to its convenience.

A propeller of the wide-blade type described having an experimental mean pitch of 2.53 ft., gives a wind on static test that flows 3.33 ft. per revolution, regardless of the rotation speed of the propeller. These values were determined for the writer by Prof. E. P. Lesley at the Leland Stanford Junior University wind tunnel, confirming his own measurements. The superspeed ratio, 3.33/2.53, is 1.32, and these figures bear so direct a trigonometrical relation to the blade angle as to suggest that air instead of being swept backward by screw pressure is driven back by precise reflection or batting action.

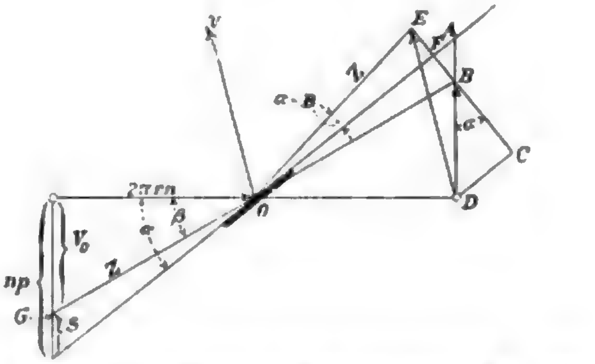

FIG. 2. DIAGRAM ILLUSTRATING TEST CONDITIONS FOR A PROPELLER OPERATING ON A FLYING PLANE OR IN A WIND TUNNEL

The diagram, Fig. 1, illustrates nearly to scale the test conditions for the propeller mentioned above having a blade angle, α, of 36 deg. The blade element indicated at O is moving toward the left at the velocity indicated by the line $BO = 2\pi rn$, around an axis parallel to CE far below the plane of the paper, and strikes an air particle at point D. The relation of particle to blade is unchanged by assuming that the particle D moves to the right at same speed against a stationary blade, and is reflected to point E in unit time. Had the blade not been in the way the particle would have reached B, hence the blade has deflected the particle in the direction BE, represented also by the vector Ov_0 with respect to the plane. Ov_0 is perpendicular to the instantaneous position of the blade when striking the particle. Under the reflection theory assumed, the axial velocity of the air particle is the projection of this vector, that is, $CE = v_0 \cos \alpha = 2\pi rn \sin 2\alpha$. To the same scale BA represents pitch multiplied by revolutions, the accepted air velocity by the screw theory. Since $BA = 2\pi rn \tan \alpha$, the ratio of superspeed velocity to screw-pitch velocity is $CE/BA = 2 \sin \alpha \cos \alpha / \tan \alpha = 2 \cos^2 \alpha$. For the 36-deg. angle of the special test propeller this ratio, since $\cos 36° = 0.81$, is 1.31, which agrees with the value 1.32 experimentally determined by pitot-tube measurement with sufficient precision to warrant acceptance of the reflection theory, especially when similar close agreement was found with a blade of 28 deg. angle and by other confirmatory tests.

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* For presentation at the Spring Meeting, Worcester, Mass., June, 1918, of The American Society of Mechanical Engineers, 29 West 39th Street, New York.

To illustrate the more complex condition of a propeller operating on a flying plane or in a wind tunnel with corresponding wind conditions, Fig. 2 is offered. Here, as before, the blade instead of rotating to the left at the velocity $2\pi rn$, is assumed stationary, and the air particle at G is assumed to move to the right at the velocity $2\pi rn$, combined with the velocity V_w, also reversed, representing the plane's translational velocity, or, in the case of a wind tunnel, that of the impressed wind. In unit time the particle moves along the diagonal path Z, strikes the blade at O, and is reflected to E. The angle of incidence and of reflection is $\alpha - \beta$. But for the blade the particle would have reached B in the same time, so that the blade action is represented by BE, while under the screw theory the motion would be BA, the slip, which is more clearly indicated as S at the left of the diagram. The axial projection ot BE is $BE \cos \alpha$, not represented in the diagram, and the ratio $BE \cos \alpha / BA = 2 \cos^2 \alpha$, the same ratio as found for static test conditions. This relation is derived as follows:

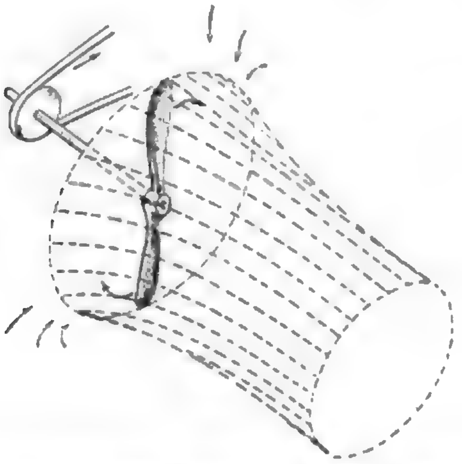

Fig. 3. Sketch Showing Direction of Air Flow from a Static Propeller

$$BE = 2FE = 2Z \sin(\alpha - \beta) = 2Z(\sin \alpha \cos \beta - \cos \alpha \sin \beta)$$

but

$$Z \cos \beta = 2\pi rn = np \cos \alpha / \sin \alpha$$

and

$$Z \sin \alpha = V_w$$

hence

$$BE = 2 \cos \alpha (np - V_w)$$

and

$$BE \cos \alpha = 2 \cos^2 \alpha (np - V_w)$$

Thus either for static or flying tests an air propeller produces a velocity or a change in velocity which has a superspeed ratio of $2 \cos^2 \alpha$ as compared with the screw-advance theory. This factor varies from nearly 2 for low pitch angles found near the blade tip to 1 for a 45-deg. angle, the steepest blade angle for effective work in propellers. For a propeller of constant pitch equal to diameter, a normal design, the superspeed ratio is 1.8 for the blade tip and 1.4 at half radius. Since the activity of propellers is confined mostly to the outer half of the blades, normal values for superspeed would be usually between 1.5 and 1.6.

In wind-tunnel tests, where alone velocities of the air can be measured satisfactorily, the propeller activity BE is combined vectorially with the wind velocity V_w, making the vector DE, represented also by Oe, the velocity to be measured. The difference between this and $DA = np$ is not very marked, except at rather heavy slip conditions. For low blade angles, however, where the superspeed ratio is more pronounced, careful speed measurements show that the air leaves the propeller at higher velocities near the blade tips than part way in, a condition inconsistent with the screw theory for standard-type constant-pitch propellers. Eiffel's "Recherches" presents an elaborate collection of data showing this condition to exist, for which no explanation is offered, but the reflection theory explains it.

When the direction of the air flow from a static propeller is investigated by means of light ribbons, they show that the air moves in a direction strictly perpendicular to the blade angle, the condition demanded by the reflection theory but not by screw action. Moreover, these ribbons indicate that the stream contracts in diameter slightly as it leaves the propeller with its rotating whirl, whereas with the squeezing action of a screw it would be expected that the air would be expanding rather than contracting. Fig. 3 is an isometric drawing to show this rotating, contracting whirl.

The most convincing demonstration of the velocity of air leaving a propeller faster than the propeller screw advance is found in a test made with two propellers connected in tandem, illustrating a wind-tunnel test. Calling the forward propeller a blower, for distinction, assume that it provides a wind at 30 miles per hour, or 44 ft. per sec., and that the propeller is driven in this wind at a speed just above idling speed, such that its revolutions times pitch is, say, 48 ft. per sec. An anemometer shows a velocity of about 50 ft. per sec. If now the blower be shut down, while the speed of the propeller is maintained constant, the wind velocity rises to 75 ft. per sec. instead of remaining constant as demanded by the screw theory.

Accepting superspeed, then, it is seen that since the air is driven backward at an excess rate, the thrust due to this unexpected acceleration is, by the Newtonian laws of dynamics, due in greater degree to speed and less to the quantity of air handled than is commonly supposed. It has long been recognized that the evaluation of dynamic thrust equations requires the questionable assumption of blade activity over a larger portion of the propeller disk than that covered by the blades alone. Indeed some authorities, such as Riach,[1] use the entire disk area as that actuated by the propeller. Seventy-mile flight at 30 per cent slip is commonly supposed to mean that the air is driven backward at 30 miles per hour, while its actual speed is nearer 50 miles per hour. This means that the column of air with respect to the plane is not 100 miles but about 120 miles per hour in length. No wonder it is difficult to get satisfactory results from air-dynamics formulæ now in use, except from well-developed empirical formulæ.

The proper interpretation of superspeed bids fair to reconcile the thrust and power values as derived from the static tests with those of wind tunnels or of flight, whereas it seems to be the common opinion today that flying performance cannot be predicted from static tests. With the precise air-dynamics formulæ sure to come, a single static test of a propeller should furnish all necessary data for the production of complete flying-performance curves.

As a preliminary empirical approximation the following formula may prove useful: $T = T_n - T_n'$, where T is flying thrust, T_n the static thrust at propeller speed n, and T_n' the static thrust at propeller speed V/p, where V is plane velocity and p propeller pitch. That is, T_n' is taken statically at what is idling speed in the wind. Since all static-thrust values are proportional to the square of the rotations, a single static thrust at any speed enables both T_n and T_n' to be derived. The physical meaning of this seems to be that the wind-tunnel blower relieves the propeller of that portion of T_n represented by idling speed, even though the propeller, giving superspeed, sends air backward when tested statically at speed V/p, faster than velocity V. Under this formula the flying thrust at 30 per cent slip is found to be 51 per cent of the static thrust at speed n.

Correct air-dynamics formulæ will not produce the changes in propeller design that might be anticipated, since propeller, or air bat, is extraordinarily efficient today. However, it is hoped that this paper may lend to a clearer conception of the underlying physical principles of air propulsion.

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[1] Efficiency Variation in Airscrews, Aviation, April 1, 1918.

Book Review

My Airman Over There. By His Wife. (Moffat, Yard & Co., New York. $1.35. 288 pp.)

This book is all in a class by itself among the countless literary productions resultant from the World War. The letters around which this book has been written by "His Wife" are those of a British fighting airman and disclose the tale of a romantic love story interspersed with gripping adventures of the air.

The latter are most thrillingly described and truly rank with that well known classic "Cavalry of the Clouds," which is paying no mean compliment to the author of these letters.

The Friedrichshafen Bombing Biplane

This machine, which bears the marks F.D.H. G.3. 326 17, was brought down by anti-aircraft fire at Isbergues on the night of February 16. A shell made a direct hit on the right-hand engine at a height of 8,000 to 9,000 feet, after which the machine covered about six miles and made a fairly good landing.

Various parts of the structure bear different dates, that on the tail being 14 1 18. The main spars are branded with a small crown and the letters Z.A.K. The following is painted on the side of the body:

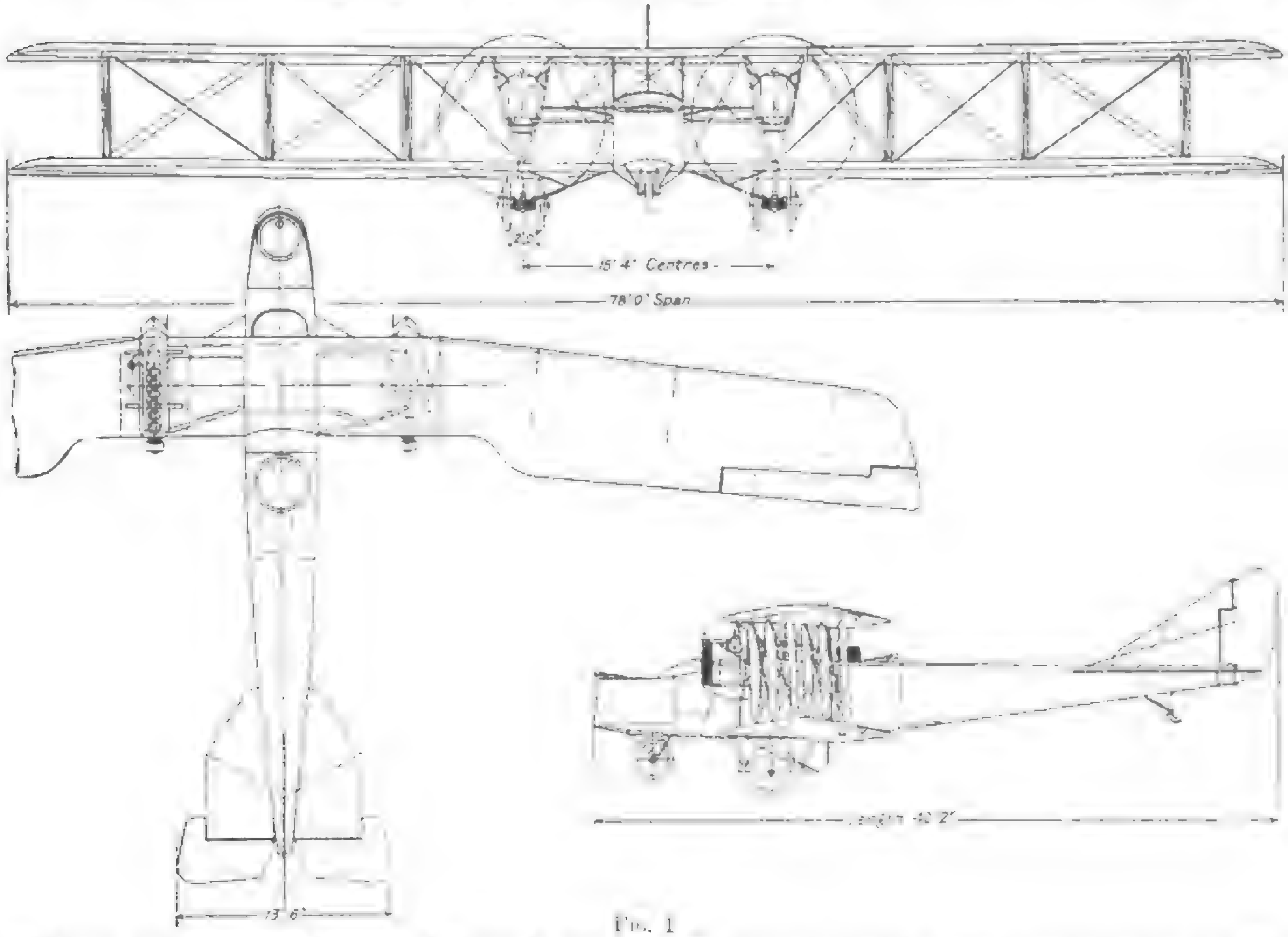


Fig. 1

Leergewicht (weight empty), 2,695 kilogrammes = 5,929 lbs.

Nutzlast (useful load), 1,235 kilogrammes = 2,717 lbs.

Zulässiges Gesamtgewicht (permissible total weight), 3,930 kilogrammes = 8,646 lbs.

Crew—This machine carried its full complement of four persons, namely, pilot, fore-gunner, after-gunner and bomber. It is known, however, that the number of crew varies considerably, as some machines of this type have only carried two persons. The accommodation is so arranged that the personnel can easily change places, all the cockpits being intercommunicating.

General Description—The general design of the machine is shown in Fig. 1, which gives plan and front and side elevations.

The principal dimensions are as follows:

Span	78 ft.
Maximum chord	7 ft. 8 in.
Gap	7 ft.
Dihedral angle in the vertical plane	1½°
Dihedral angle in the horizontal plane	6°
Total area of main planes	934 4 sq. ft.
Area of upper main planes without flap	480 sq. ft.
Area of lower main planes without flap	454 4 sq. ft.
Load per square foot	9 24 lbs.
Weight per horsepower	16 6 lbs.
Area of flap of upper wing	21 6 sq. ft.
Balance area	1 8 sq. ft.
Area of flap on lower wing	16 sq. ft.
Balance area	1.56 sq. ft.
Total area of fixed tail planes	57.6 sq. ft.
Total area of elevators	32 sq. ft.
Balance area of one elevator	1.7 sq. ft.
Area of fin	20 sq. ft.
Area of rudder	19.2 sq. ft.
Balance area of rudder	3 sq. ft.
Maximum cross section of body	19.2 sq. ft.
Horizontal area of body	133 sq. ft.
Vertical area of body	131.2 sq. ft.
Length overall	42 ft.

The machine is built up upon a central section, to which are attached the forward and rearward portions of the body and the main planes. This central section comprises the main cell or cabin of the body, containing the tanks, bombs, etc. It also embraces the engines and the central portion of the upper and lower planes. The latter, together with the engine struts, are largely built up of steel tube, as is also the landing gear.

The central portion of the body, which measures 4 ft. across by 4 ft. 3 in. in height, consists of a box formation made of ply wood, strengthened by longerons and diagonals, and transversely stiffened by ply-wood bulkheads. The bulkhead furthest forward acts as an instrument board, behind which are side by side the seats of the pilot and his assistant. The former has a fixed upholstered seat, whilst that of the latter is folding, consisting of a light steel tubular framework with a webbing back-rest.

Underneath these two seats is the lower main gasoline tank. Behind this cockpit the body is roofed in with ply wood, the rear part of which roofing is detachable so as to give access to the second main gasoline tank, which is at the rear end of the main body section. By this means a small cabin or covered passage-way is provided, at each side of which are the racks for the smaller bombs.

Central Portion of Wings—The central and non-detachable portion of the upper plane has a span of 19 ft. 5 in., whilst at each side of the nacelle the lower plane fixed portion measures 7 ft. 8 in. The main wing spars in this central portion are of steel tube, roughly 2 in. in diameter, with a wall thickness of 1/16 in.

As shown in Fig. 2, these spars are braced by steel tubes arranged in the form of an X, the manner in which the bracing tubes are attached to the main spars being shown in the sketch Fig. 3.

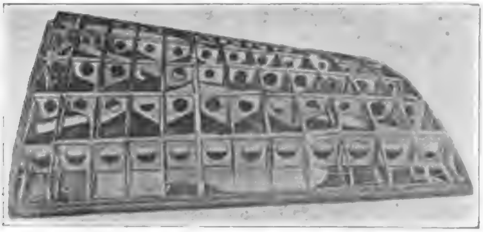


Fig. 2. Center Section of Lower Main Plane with Three-Ply Surfacing Removed

The lugs are built up by welding, and are pinned and riveted in position, the joint being of the plain knuckle type.

The upper surface of the lower plane is, so far as the central section is concerned, covered in with three-ply wood.

In this portion the main ribs are of three-ply, with spruce flanges. Between each main rib is a cut-away rib, the design of which is shown in the sketch Fig. 4. This, unlike the main ribs, is one piece of wood, and not built up. For the greater part of its length it applies to the top surface only, being cut away to pass clear of the cross bracing tubes.

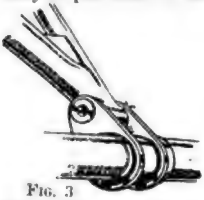


Fig. 3

As shown in Fig. 2 the plane is further stiffened with transverse members consisting of three-ply panels between each rib strengthened by grooved pieces top and bottom.

The central section of the upper main plane is in one piece and is covered top and bottom with fabric. In order to facilitate the removal of the engines, detachable panels measuring 1 ft. 11½ in. long by 1 ft. 8 in. deep are let into the trailing edge immediately over the engine bearers. These panels are socketed in front, and at the rear are joined up at the trailing edge with U section sheet steel clips and bolts.

The struts which connect the top of the nacelle to the upper plane are tubular and of streamline section, as are also the engine bearer struts. A section of one of the latter is given in Fig. 5. The thickness of the wall is one-sixteenth of an inch.

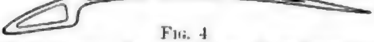


Fig. 4

The method of attaching the lower end of the engine struts to the tubular steel spars is shown in the sketch Fig. 6, from which it will be seen that a welded Y socket is used and secured by a pin joint, the ends of the pin acting as anchorages for the attachment of the bracing wires.

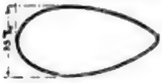


Fig. 5

This sketch also shows the lugs which respectively support the detachable portion of the main planes and the vertical strut of the landing chassis. The engine bearer struts are pushed into the Y socket and pinned in position, the pins being afterwards brazed into the socket. At their upper ends the engine struts are fixed to the top plane spars with pin joints.

Construction of Wings—The detachable portions of the wings are fixed to the center section by pin joints, one part of which is shown in Fig. 6, the male portion being represented in Fig. 9. The chord of the wing in the line of flight varies from approximately 7 ft. 8 in. to 7 ft. 5 in., and the wing section is shown shaded in Fig. 10. In order to provide a basis of comparison the R.A.F. 14 wing section is superimposed and drawn to the same scale.

The main spars are placed one meter apart, the front spar being 272 mm. in the rear of the leading edge. Both spars are of the built up box type, as shown in Figs. 11 and 12. The former is the leading spar and the latter the rear spar. These spars are of spruce, and each half is furnished with several splices, so that the greatest single length of timber in them is not more than 14 ft. The splices, which occur in each half alternately, are of the plain bevel type about 15 in. long and wrapped with fabric. A fabric wrapping is also applied at short intervals along the spar.

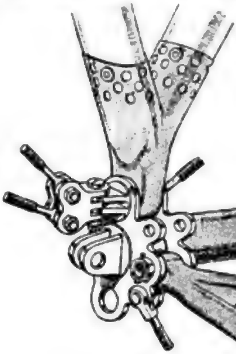


Fig. 6

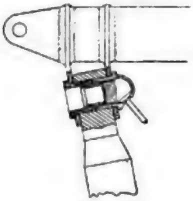


Fig. 7

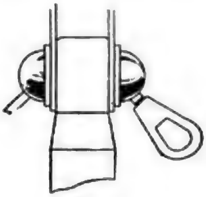


Fig. 8

Internal cross bracing between the main spars is afforded by steel tube cross members and cables attached as shown in the sketch Fig. 9.

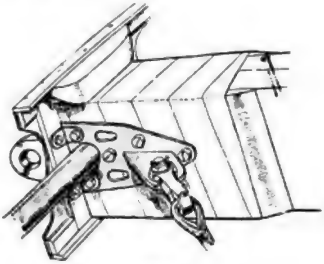


Fig. 9

The main spar joint consists of a steel plate 19 mm. thick embedded in the spar end and held in position by five bolts, which pass through a strapping plate surrounding the end of the spar. This plate also carries the attachment for the

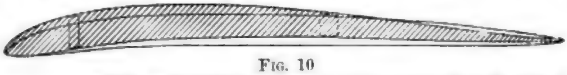


Fig. 10

bracing cable and is furnished with a spigot which locates the bracing tube. It will be seen that at this point the spar is provided with tapered packing pieces of hard wood glued and held in position by fabric wrapping.

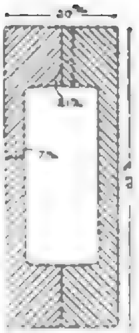


FIG. 11

The main ribs are placed 360 mm. apart. Between them are auxiliary formers, consisting of strips of wood 20 mms. × 10 mms. thick, which run from the leading edge to the rear spar. The main ribs consist of ply wood webs socketed into grooved spruce flanges, which are tapered off, except where they are met by a longitudinal stringer. The leading edge is solid wood moulded to a semi-circular section of approximately 65 mm. diameter. Where the rib web abuts against it, packing pieces are glued each side. Between the main spars the web of the rib is divided by three vertical strips into four panels and in each of these it is perforated, leaving an edge all around about 72 mm. wide.

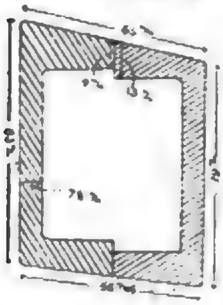


FIG. 12

As shown in Fig. 9, the upper flange of the main ribs is carried clear of the leading spar by means of packing pieces. In the case of the rear spar, packing pieces are also used under the rib flange, as shown in Fig. 13.

The lower main planes for a width of about 2 ft. 3 in. at their inner end are covered as to their top surfaces with three-ply wood.

The interplane struts are attached to the main spars by joints of the type shown in Fig. 14. This, it will be seen, follows the typical German practice of partially universal jointed mountings for the cable attachments. At the points of attachment of these strut joints, suitably tapered packing pieces of hard wood surround the spars, which at these points are also wrapped with fabric.

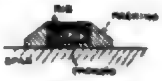


FIG. 13

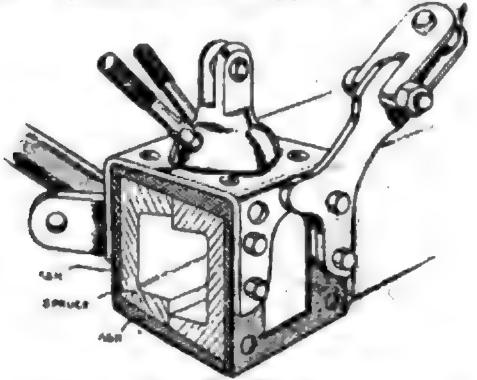


FIG. 14

Struts—Outside of the center section the interplane struts are of wood built up, as shown in the section Fig. 15, of five separate pieces. The curved portions are of timber which has not yet been identified, but is apparently of poor quality. The cross web is of ash. The strut is wrapped at frequent intervals with strips of fabric and is fitted with a socket joint of the type shown in Fig. 16. The outer pair of struts are of smaller section than the main struts, but are built up in a similar manner. Their section is 125 mm. × 40 mm.

Ailerons—The framework is principally of welded steel tube wrapped with fabric.

A notable point is the thick section of the leading edge of the balanced portion, as shown in Fig. 17.

Fin and Fixed Tail-Planes—The framework of these is steel tube and in the case of the tail-planes wooden stringers running fore and aft are arranged at intervals. The tail-planes are supported by diagonal steel tubes of streamline section, on the under side of which sharp steel points are welded to prevent these stays being used for lifting purposes.

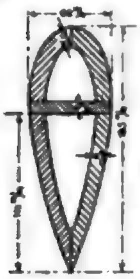


FIG. 15

Elevators and Rudders—The framework in each case is of steel tube, the main tube being 35 mm. in diameter and the remainder 15 mm.

Bracing—Throughout the wings, both internally and externally, the bracing is by means of multi-strand steel cable.

Body (Rear Portion)—At the after-gunner's cockpit the section of the body has a rounded top, which is gradually smoothed down into flat. The section, for the greater part of the length, is rectangular, and the frame is built up in the usual maner with square section longerons and verticals, the joints being arranged as shown in Fig. 18. The cross bracing wires along the sides, top, bottom, and diagonal are of steel piano wire and are covered with strips of fabric, as shown in this sketch, where they lie adjacent to the fabric body covering.

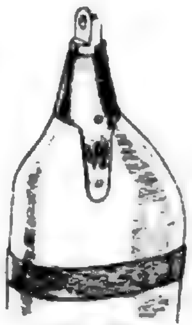


FIG. 16

The vertical and horizontal compression members are located by spigots. The joint consists of a plate which completely surrounds the longerons, its two ends being riveted together to form a diagonal bracing strip. For the last few feet at the tail the body is covered with thin three-ply.

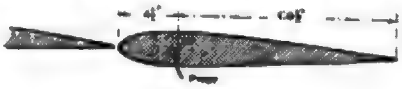


FIG. 17

The body is covered with fabric, which is held in position by a lacing underneath and is consequently bodily removable.

The floor of the after-gunner's cockpit is elevated above the bottom of the body. Immediately underneath this cockpit is a large trapdoor, which is hinged at its rearward end and furnished with two large celluloid windows. It is held in its "up" position by a long spring and a snap clip. No means could be found by which it could be fixed in its closed position. As footsteps are provided for all the cockpits, this trapdoor is evidently not intended for ingress and egress. It could be employed in connection with a machine gun firing backwards, as in the Gotha, but no machine gun mounting was fixed in this machine for this purpose.

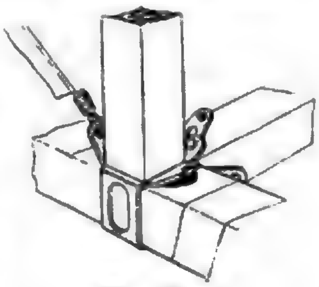


FIG. 18

The rear portion of the body is attached to the center section of the body by a clip at each corner. This is shown in Fig. 19. The rear portion carries a male lug, which engages with the two eyes, and is held in position by a ⅜ bolt. Four other bolts in tension pass through the sheet metal clip, as shown in the sketch. In each case the lugs are furnished with sheet steel extensions which, as shown in the sketch Fig. 19, are sunk flush into the top and bottom surfaces of the body longerons and are there held with three bolts. The corner joint is welded sheet steel, and there is an additional diagonal sheet steel joint which serves the secondary purpose of providing an anchorage for the bracing wires. As this body joint is level with the plane of rotation of the propellers, it is armored both on the nacelle and on the rear portion of the body with a hinged covering of stout sheet steel lined with felt. A plate of armor a foot wide also extends down each side of the nacelle at this point.

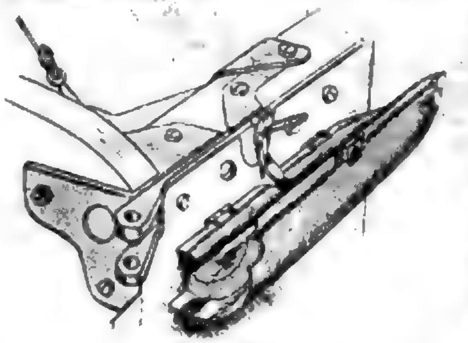


FIG. 19

(To be continued)

International Aircraft Standards Conference

By Coker F. Clarkson

General Manager of the Society of Automotive Engineers

The American Aircraft Commission, which spent several weeks in Europe recently in conference with engineering representatives of the Allies, on the formulation of harmonious specifications of materials and mounting and other dimensions of parts for aircraft, was constituted of three representatives from the Society of Automotive Engineers, three from the International Aircraft Standards Board, two from the United States Signal Corps, and one each from the National Advisory Committee for Aeronautics, the Bureau of Standards, the United States Navy, The American Society of Mechanical Engineers, and the American Society for Testing Materials. The request that the various societies appoint delegates having been acted upon, the whole matter was referred to the Government, and the personnel of the Commission decided upon after consultation with representatives of Governmental, manufacturing and organizing organizations.

The British Air Board (now the Air Council) had, in conjunction with the British Engineering Standards Committee (now the British Engineering Standards Association), formed a Sectional Committee to deal with the standardization of the components of aircraft and aircraft engines, and nominated several sub-committees to consider the details of the different branches of the subject. The British organization had been in communication with the French and Italian standardization committees.

The belief that the conferences just had would constitute a real advance, and facilitate ultimate international standardization, was borne out. The delegates had advisory powers only, the arrangement being that after conferring they would make recommendations to the authorities by whom they were appointed.

The members of the American Commission attended scores of sessions and conferences with their European brethren. Many aircraft and engine manufacturing plants were visited. Government factories, repair stations, laboratories and salvage depots were inspected and their methods studied. A formal International Conference was held in London, representatives of France, Italy, Great Britain and the United States being present. The general subject of cooperation of the Allied Powers, through exchange of ideas and standardization of aircraft materials, was discussed. All were in favor of a permanent aircraft standards organization representing at least five of the Allied Nations.

The following branches of the service and organizations of our Allies were represented in the conferences:

British.—Technical Department of Aircraft Production and Aeronautical Supplies of the Ministry of Munitions, the Admiralty, the National Physical Laboratory, the Aeronautical Society of Great Britain, the Society of British Aircraft Constructors, the Aircraft Steelmakers' Committee, the Technical Committee of Motor Industries, Aeronautical Inspection Directorate, Brass and Copper Tube Association, British Electrical and Allied Manufacturers' Association, British Ignition Apparatus Association, Cable Makers' Association, ball-bearing manufacturers, the Weldless Tube Association, the Irish Power Loom Manufacturers' Association, the Iron and Steel Institute, and the Steel Research committee.

French.—Section Technique de l'Aéronautique and Service de l'Aviation.

Italian.—Mission pour l'Aéronautique Militaire Italienne à l'Etranger, and Services d'Approvisionement de l'Aviation Italienne.

The prime objects of the conferences were to facilitate the sending of most usable supplies to England, France and Italy from the United States and to settle mutually satisfactory standards and specifications; to make parts, fittings and instruments interchangeable on aircraft produced in the different countries.

England and France and Italy, during the past three years, have worked with an energy never before equalled, and have made tremendous strides in aircraft design and production. The members of the American Commission were highly encouraged by what they saw. The spirit of cooperation in which they were met, the wholehearted expression of desire to work jointly to achieve the largest result toward the one thing worth considering today, were most gratifying.

The production of our Allies is now large. The work of their technical and scientific men in aircraft lines has been carried on in a very extensive and effective way.

Specifications for Steels.—Progress was made at the conferences abroad in the formulation of Allied Standard specifications for aircraft steels, using the current American, British, French and Italian specifications as a basis; covering both the general procedure for testing and the chemical and physical requirements of wrought steels.

Fabrics.—The American standard fabrics have been submitted for test, and specifications have been recommended.

Dopes.—The British specifications and methods of inspection were studied carefully. The science and economics of the manufacture of these articles are, of course, important.

Radial Bearings.—In the metric sizes the S. A. E. and the British ball-bearing series are identical, except that six S. A. E. sizes have not been included in the British list. A revision of tolerances and limits recommended by the British and the American delegates is under consideration. Limits of eccentricity in radial bearings and outside dimensions of thrust bearings were other subjects of study.

Spark Plugs.—The 18-mm. spark plug, incorporating the best features of the British and the S. A. E. plugs, has been recommended for use on American and British stationary cylinder and rotary engines. Practically the same plugs are used in France and Italy.

Magnetos.—The dimension specifications for British and for American magnetos are substantially the same, with the exception of one dimension of magneto space. The American specification of the taper as one in five is the same as the British specification of the taper as one in ten, owing to the fact that the British refer to the slope of the conical surface to the axis.

Nomenclature.—Representatives of the National Advisory Committee for Aeronautics and of the Society of Automotive Engineers are conferring with the committee of the Aeronautical Society of Great Britain on nomenclature.

Instruments.—It is necessary to standardize further the connections and attachments and also the general character of the indication of instruments.

International Unification of Units of Measurements.—The plan, provisionally adopted by the sub-committee of the International Commission on Pipe Threads, which met in Paris, July, 1914, for a standard method of designating units of construction, was discussed, with reference particularly to screw threads and gear-wheel teeth, the idea being to seek a unit which could be used when either the inch or the metric system is employed. Taking screw threads as an illustration, a system of notation was outlined by which each screw would bear a distinctive number based on the diameter in eighths of an inch, and the pitch in the number of threads per inch or per 127 mm. (which equal five inches), without reference to the unit in which the measurement might be made. For example, a ¾-in. U. S. standard bolt having 10 threads per inch would be designated a "6 x 50" bolt in countries using the metric system. The selection 127 mm. as the length over which the number of threads should be stated in countries using the metric system is based on the fact that this gives *whole* number of turns, these being five times the number of threads per inch.

The very difficult problem of bringing together the advocates of the metric and of the inch bases is in abeyance, but it is felt by some that the plan outlined above may afford the first step.

Plywood and Cements.—The British specifications for plywood and for casein cement were discussed in detail.

Glue.—The practices in the preparation and use of glue are much the same in the United States and Great Britain. Mechanical methods of application and electrical methods of heating are used largely here, but neither of these methods is common in England. Comparative tests of British and American methods of testing glue are being made.

Timber.—The question of spruce supply was naturally discussed. Kiln procedure has been simplified, the results being satisfactory almost invariably. It is appreciated by all that the splicing of wood is an important subject. Additional approved designs of laminated and box spars will be recommended.

Structural Tubing.—The possibilities of further development in the methods of drawing and heat treating tubing are being studied, with promise of marked improvement.

Lubricating Oil and Gasoline.—The gasoline and lubricating oil questions require continued attention, to assure adequate supplies of proper quality. Compounded oils will be furnished where required, as well as grades of gasolines of proper homogeneity and low end-point.

Propeller Hubs and Fittings.—Propeller hub and fittings practice will be further unified so far as shall prove advisable and possible.

Water and Fuel Piping.—Coordination of water and fuel piping standards is largely dependant on thread practice. The use of outside dimension only for nominal diameters of metal tubing has been recommended by the British and the American Committees.

Electrical Apparatus.—The practice in electrical apparatus peculiar to aircraft, such as signal lights, radio, generators, batteries, heating and protective devices, is under consideration in view of more extensive use.

Wheels and Tires.—The British and American practice in wheels and tires are substantially in accord. Discussion is being had as to the advisability of extending the list of wheel sizes which has been adopted here.

The number of tire sizes will be kept to the lowest possible minimum.

Steel Wire Cables.—The British and the American steel wire cables are sufficiently alike to be practically interchangeable. The same thing is true of high-tension steel wire.

Turnbuckles.—It is felt that similarity of design is not necessary in turnbuckles, satisfactory interchangeability being securable if the fork-end and pin dimensions are standardized.

Gasoline Rubber Tubing.—Comparative tests are being made of gasoline rubber tubing made to British and to United States specifications.

Installation of Apparatus.—Standardization will be effected so far as possible in the location, mounting, size, and indication of direction and method of operation of instruments and apparatus.

The Work in Hand.—The single aim in considering the various matters is to ascertain to what extent we can, without interfering with our productive capacity, adopt European standards with advantage; to what extent we can assist more effectively in cases of European conformity with our practices; following the course that will bring the best results. That which does not contribute to the winning of the war is of quite secondary importance. Anything that does contribute to the winning of the war is obviously of prime importance.

As was pointed out by Winston Churchill, British Minister of Munitions, at the Inter-Allied Aircraft Conference, the detailed standardization of aircraft materials among the Allied Powers now fighting the Germans, is based on principles so obvious that they really do not require emphasis; the principle of a common front, of the freest possible communication, a lateral communication, between all parts of the front, of common reserves, upon which all can draw at any moment, of interchangeability of troops and of materials of all kinds at any moment—these are clearly steps which enable us, although we consist of many nations, fighting for a common cause, to realize day by day and week by week the continuous approach toward complete unity of action and all the efficiency and integrity of action which come from a simple purpose and a single system.

Aliens in American Factories

Industry faces a difficult problem in the unfriendly employe, which, according to the Man-Power Engineering Service of the National Americanization Committee, can be solved by the following method:

First of all take a census of all employes and divide them into four classes: native born, naturalized citizens, friendly aliens, alien enemies. If they are naturalized citizens of enemy alien descent they had better be classed industrially with alien enemies until something of their history and record is known. A man born on another soil has to *prove* himself for America. A certificate of naturalization granted under our inadequate requirements, where often a job is the goal, is not enough to class him with a native American.

Second.—Make an analysis or a map of your plant, showing its vulnerable spots. Where will a fire do the greatest damage, where is waste accumulated, what hydrant is most vital in extinguishing a fire, where is the control of your lighting system, where will an explosion cause the most damage, what machines are most vital or difficult to replace, where can goods in transit be tampered with easiest? A dozen other questions will suggest themselves.

Find out what kind of workmen are in charge of these vulnerable points. If they are enemy aliens, transfer them at once. Don't wait to have them prove their loyalty. Some other point in the factory will not decrease their efficiency and it may increase safety. The fire-brigade and the man who can reach the hydrant the quickest ought to be loyal American workmen—just as men in the boiler-room and at delicate machines should also be. What do you know about these men?

Surveillance and guards and sentinels are the next most important considerations. Their number and location should be determined by the numbers and location of alien enemies and persons of doubtful loyalty, and by the strategic points to be guarded. *Both systems are necessary*—one for men; the other for places. They check each other and insure safety. With only one method there will at various times be exposed points. One agent may be diverted but two or more are difficult to divert simultaneously.

When fences are put up and windows barred and guards established, do you consult the factory plan to see that every vulnerable part is included or do you follow the example of one concern in New England and leave the transformer out in a field, fifty feet outside of the fence, where an enemy with a tin can of powder could paralyze the plant? Safeguarding is a job of engineering—not a make-shift job that anyone can do. It would be interesting for each industrial leader to find out who handled this work in his own plant.

Lighting is an important essential. Every possible improvement should be made; vulnerable points should be especially well-lighted. *Keep alien enemies and persons of doubtful loyalty in the light all of the time.*

Keep outsiders out. This is no time for outsiders or persons without official authority or business in war plants. Verify credentials of visitors. When they get in, see that they go only to the place they are supposed to go. Don't send them alone. Escort them in, stay with them, and escort them out, or supply them with a "guide" who will do so.

One way to keep outsiders out is to reduce the labor turnover. Every time a new man is taken on who is not known, it increases the risk.

Ask every new employe if he has a registration card. If manufacturing war supplies try to get every alien enemy out—not by throwing him out, but by exchanging with some industry that is not manufacturing war supplies. A man discharged because he is an alien may go to another plant in bitterness of spirit and wreck it for no reason than to get even with his first employer.

Permits should be required by employes to go to different parts of the plant. A general tag is not sufficient.

Appoint some employe as an aliens captain in the plant and give him a committee if it is advisable. It will become his business to spot anti-American propaganda and sentiment, to make such plans and maps as have been suggested, to supervise registration, recommend transfers and command the guards and sentinels. Call him by any preferred name, but give him the whole job of looking after the safety of the plant from the man-power end.

Take a personal interest in the alien. If it is necessary, set up an information bureau to help him understand drafts and regulations and registration. If he wants to learn English and become a citizen, help him do so. See that he gets American information on bulletin-boards, in pay envelopes and otherwise, to offset the anti-American material sent him or told him. (Over 140,000 sets of civic lessons in foreign languages have already been handled by industries through pay envelopes.)

The American Government cannot protect the plant that will not protect itself, and the invisible war being carried on in American industries must be won by American manufacturers or the visible war in Europe will be lost.

Official Description of the Liberty Engine

The first official description of the Liberty aero-engine was issued on May 15 by the War Department, after many fanciful reports as to its characteristics had generally gained credence.

The official statement makes highly interesting reading on several accounts as one is able to judge that the Liberty engine does not embody any revolutionary feature in either method of construction or operation. This will tend to increase general confidence, for whatever failings this engine may still display, are a matter of detail which should not prove difficult to straighten out in the necessary process of "tuning up."

It is highly proper that official credit is at last given to the engineers who have been principally responsible for the design of the Liberty engine, for once the War Department has departed from its customary policy of secretiveness in telling the public about our military preparations. While one fully realizes the value of this policy in certain specific cases where information may prove of value to the enemy, no harm may be expected from the publishing of details of the Liberty engine, since it follows well known engineering standards, while on the other hand it will go a long way to quiet sundry rumor mongers and afford the technical man and thereby the public the conviction that nothing is fundamentally wrong with the Liberty engine.

The Official Description

Here is the statement prepared by the War Department:

The designs of the parts of the Liberty engine were based on the following:

Cylinders: The designers of the cylinders for the Liberty engine followed the practice used in the German Mercedes, English Rolls Royce, French Lorraine-Dietrich, and Italian Isotta-Fraschini, before the war and during the war. The cylinders are made of steel inner shells surrounded by pressed steel water jackets, a method of applying which the Packard Motor Car Co., by long experiment, had developed. The valve cages are drop forgings welded into the cylinder head. The principal departure from European practice is in the location of the holding-down flange, which is several inches above the mouth of the cylinder, and the unique method of manufacture evolved by the Ford Co. The output is now approximately seventeen hundred cylinder forgings per day.

Cam Shaft and Valve Mechanism Above Cylinder Heads: The design is based on the Mercedes, but was improved for automatic lubrication without wasting oil, by the Packard Co.

Cam Shaft Drive: The cam shaft drive was copied almost entirely from the Hall-Scott motor; in fact, several of the gears used in the first sample engines were supplied by the Hall-Scott Motor Car Co. This type of drive is used in the Mercedes, Hispano-Suiza and other engines.

Angle Between Cylinders: In the Liberty engine the included angle between the cylinders is 45 deg.; in all other existing twelve-cylinder engines it is 60 deg. This feature is new with the Liberty engine, and was adopted for the purpose of bringing each row of cylinders nearer the vertical and closer together, so as to save width and head resistance. By the narrow angle greater strength is given to the crank case and vibration is reduced.

Electric Generator and Ignition: A Delco ignition system is used. It was especially designed for the Liberty engine to save weight and to meet the special conditions due to firing twelve cylinders with an included angle of 45 deg.

Pistons: The pistons of the Liberty engine are of Hall-Scott design.

Connecting Rods: Forked or straddle-type connecting rods, first used on the French DeDion car, and on the Cadillac motor car in this country, are used.

Crank Shaft: Crank shaft design followed the standard twelve cylinder practice, except as to oiling. Crank case follows standard practice. The 45-deg. angle and the flange location on the cylinders made possible a very strong box section.

Lubrication: The first system of lubrication followed the German practice of using one pump to keep the crank case empty, delivering into an outside reservoir, and another pump to force oil under pressure to the main crank shaft bearings. This lubrication system also followed the German practice in allowing the overflow in the main bearings to travel out the face of the crank cheeks to a scupper which collected this excess for crank pin lubrication. This is very economical in the use of oil and is still the standard German practice.

The present system is similar to the first practice, except that the oil, while under pressure, is not only fed to main bearings but through holes inside of crank cheeks to crank pin, instead of feeding to these crank pins through scuppers. The difference between the two oiling systems consists of carrying oil for the crank pins through a hole inside the crank cheek instead of up the outside face of the crank cheek.

Propeller Hub: The Hall-Scott propeller-hub design was adapted to the power of the Liberty engine.

Water Pump: The Packard type of water pump was adapted to the Liberty engine.

Carburetor: A carburetor was developed by the Zenith Co. for the Liberty engine.

Bore and Stroke: The bore and stroke of the Liberty engine is 5x7 in., the same as in the Hall-Scott A-5, A-7, and twelve-cylinder engines.

Remarks: The idea of developing Liberty engines of four, six, eight and twelve cylinders with the above characteristics was first thought of about May 25, 1917. The idea was developed in conference with representatives of the British and French Missions, May 28 to June 1, and was submitted in the form of sketches at a joint meeting of the Aircraft Board and the Joint Army and Navy Technical Board, June 4. The first sample was an eight-cylinder model, delivered to the Bureau of Standards, July 3, 1917. The eight-cylinder model, however, was never put into production, as advices from France indicated that demands for increased power would make the eight-cylinder obsolete before it could be produced.

Work was then concentrated on the twelve-cylinder engine and one of the experimental engines passed the fifty-hour test Aug. 25, 1917.

After the preliminary drawings were made, engineers from the leading engine builders were brought to the Bureau of Standards, where they inspected the new designs and made suggestions, most of which were incorporated in the final design. At the same time, expert production men were making suggestions that would facilitate production.

The Liberty twelve-cylinder engine passed the fifty-hour test, showing, as the official report of Aug. 25, 1917, records "that the fundamental construction is such that very satisfactory service with a long life and high order of efficiency will be given by this power plant, and that the design has passed from the experimental stage into the field of proven engines."

An engine committee was organized informally, consisting of the engineers and production managers of the Packard, Ford, Cadillac, Lincoln, Marmon and Trego companies. This committee met at frequent intervals, and it is to this group of men that the final development of the Liberty engine is largely due.

In addition to the above facts, credit might properly be given to Mr. Hunt for the development of the water-jacket system for the Packard aero-engine, and to the Hall-Scott company for the crankshafts, since the dies for the four- and six-cylinder Hall-Scott engines were later reworked for the eight- and twelve-cylinder Liberty engines, respectively. It may also be added that the Hall-Scott company had completed four-, six-, eight- and twelve-interchangeable cylinder engines before the Liberty design was started.

While it is not generally known that four- and six-cylinder Liberty engines were designed, the fact appears that they were not only designed but actually made.

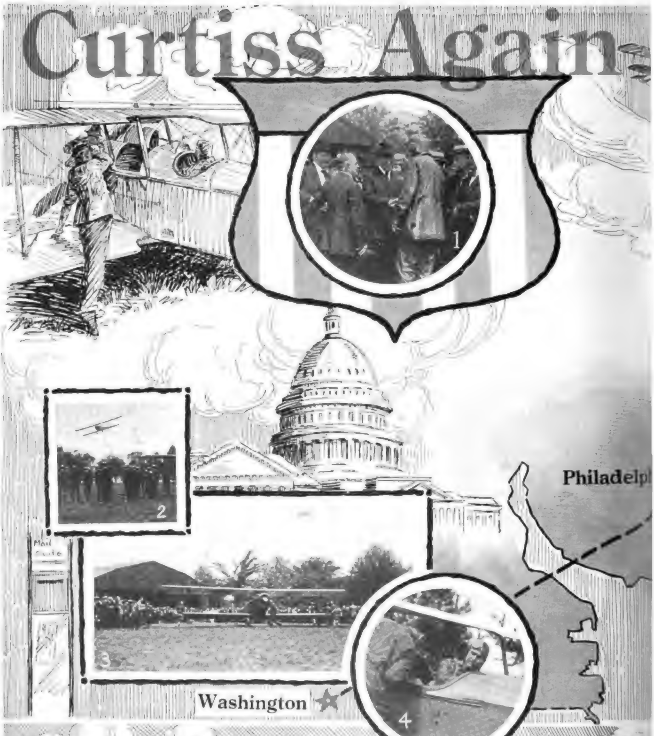
Signal Corps Air Section Needs 10,000 Mechanics

Call has been issued for ten thousand machinists, mechanics, chauffeurs and other skilled workmen needed at once by the aviation section of the Signal Corps, it was stated, and announcement was made that additional increments must be obtained from the same classes in the near future.

The degree to which the aviation program of the army depends upon highly skilled labor is shown by the statement that "ninety-eight of every hundred men in the aviation section must be skilled in some branch of work."

"Men registered in the draft," said the announcement, "may be induced into this service by applying to their local draft board. Men not registered may enlist at any recruiting office. Further information may be had by applying to the air division, personnel department, Washington, D. C.

Curtiss Again



The first regular aerial mail service between New York and Washington was started May 15th, 1918. Curtiss machines were used.

Lieutenant George L. Boyle left Washington in first Curtiss mailplane with Postmaster-General Burleson's official opening letter; President Wilson cancelled and autographed aeromail stamp.

Lieutenant Howard P. Culver took Boyle cargo, Philadelphia to New York, in one hour, ten minutes. Mail, Lieutenant Torrey H. Webb carried from New York to Philadelphia, reached capital in Lieutenant James C. Edgerton's plane three hours twenty minutes later. Flying time, Washington to New York, since reduced to two hours, 20 minutes.

Aerial postal service in U. S. first started by Postmaster-General Hitchcock in 1911, flying in Curtiss biplane, Nassau to Mineola, L. I. In 1912, Mr Hitchcock licensed ten Curtiss flyers to carry mail; tests then made in New York, Georgia, Texas, Arkansas, North Carolina. Hugh Robinson, Curtiss pilot, delivered mail along Mississippi River from Minneapolis, 375 miles.

1. The President and Mrs. Wilson, Postmaster-Genera

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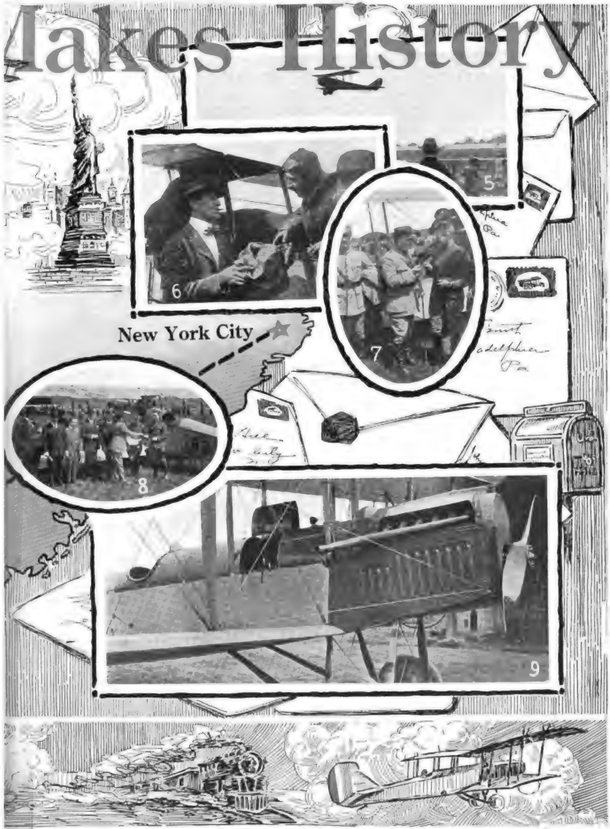
akes History



Cabinet members, and other officials bidding
Boyle good luck on the initial mail trip from
to New York.
st plane piloted by Lieutenant Edgerton arrived
gton at 2.50 p.m., flying 153 miles from Phila-
one hour and 26 minutes.
rt of the first aerial mail service from Potomac
hington.
ant Edgerton arrives in Washington with the
from Philadelphia.
ant Webb leaving Belmont Park on the first
trip of the New York-Washington Aerial Mail Route.

6. Lieutenant Culver handing his bag of mail over to New York Post Office officials after flight from Philadelphia to Belmont Park, New York.

7. Lieutenant Henri Farre, official aviation artists of the French government, presents Lieutenant Webb with a good luck horse-shoe just before the inaugurating flight.

8. Postmaster Patten of New York, Aero Club, and City Officials wishing Lieutenant Webb Godspeed.

9. A close-up of one of the Curtiss machines made for Aerial Mail Service, showing mail-carrying compartment.

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The 1917 Fokker Triplane

The following report has been issued by the British Air Ministry on the Fokker triplane, which was briefly described in the last issue of AVIATION. A fuller report may be issued in the near future, if further inquiry shows that the machine has features of interest. At present, however, the Fokker appears to be one of the poorest of modern German designs.

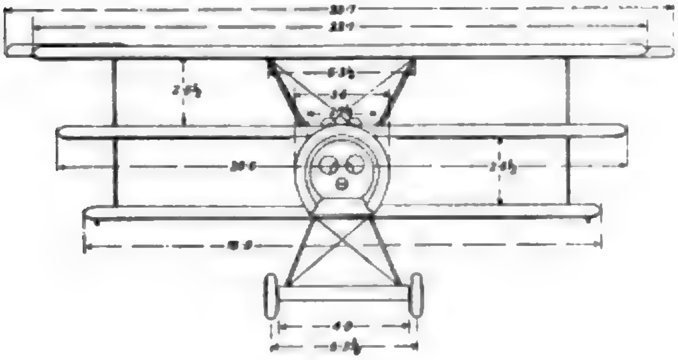

FIG. 1

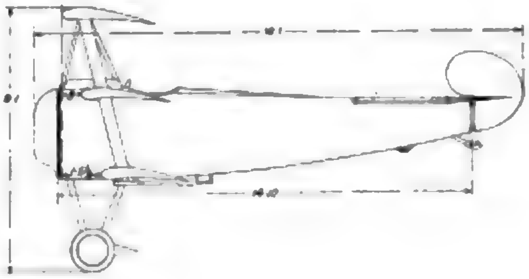

FIG. 2

General Description.—As regards outline design, the machine is somewhat similar to the Sopwith triplane and is in general of orthodox type.

The chief point which arises from a preliminary examination is the absence of external bracing wires. This point will be dealt with later.

Constructional Design.—It is from this standpoint, probably, that the machine is of greatest interest. The designer appears to have made every effort to reduce head resistance, even at the expense of increase in weight. In some respects, also, his efforts have tended to grave structural weakness.

Wing Structure.—The unique "twin" spar is shown in Fig. 3. It consists of two box-section tapering spars joined by transverse ply-wood. As far as can be gathered at present, the fore and aft shear strength of this built-up member is supplied by one port and one starboard bulkhead of ply-wood in each plane. This appears quite inadequate, especially in a high-speed machine, even if we disregard the possibility of buckling of the laterally unstabilized ply-wood in nose-diving.

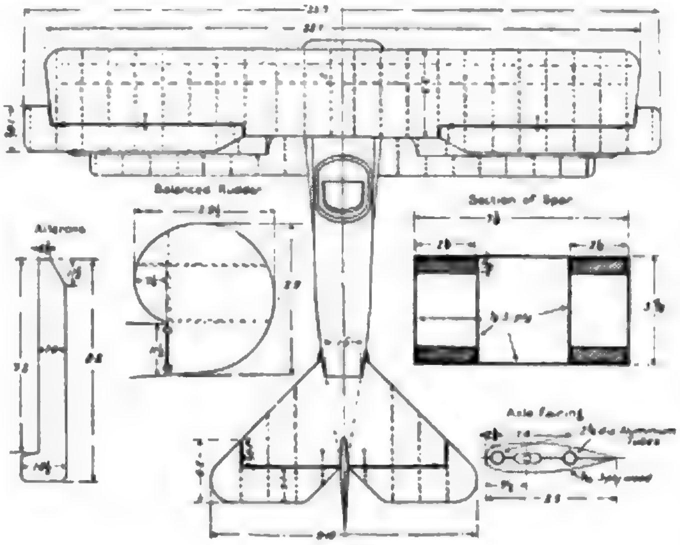

FIG. 3

Apart from this point, the internal wing structure presents no peculiarities. From the front spar to the leading edge, the upper surface is stiffened with ply-wood as is usual on many modern scouts.

The nature of the main cellule structure is a typical example of the high price paid for reduction of resistance. Interplane wiring is dispensed with, and structurally the main frame may be regarded as three pairs of cantilevers, tied by pseudo-struts near the wing tips.

On a machine of relatively short span this cantilever construction may be rendered possible by the use of spars of great depth, and the ply-wood box type employed meet this condition, owing to the abnormally high thickness-chord ratio of the aerofoil section. It is questionable whether the gain in overall efficiency by deletion of bracing wires is sufficient to balance the loss due to the use of a "high lift" section; this question naturally becomes more acute at high speeds, especially when the altitude is not approaching the ceiling; it is also rendered acute by the abnormally small gap-chord ratio employed.

The function of the interplane "struts" appears to be that of ties which partially distribute the load from plane to plane. Their section is such that they can hardly be expected to withstand reverse loading, and it is thought that this fact may be one explanation of the bad name which the Fokker has earned by breakage in the air.

Tail Unit Structure.—Here again we find that reduction of resistance has been attained by deletion of external bracing. In this case, however, the tail unit being largely of tubular construction the cantilever structure, beside being heavy, is very weak. The proportions of the framework are approximately such as obtain on most normally-braced frame works, and once more an explanation suggests itself for the structural failures experienced on this type.

Body Structure.—The framework of the body is built up from steel tubing butt-welded at the joints. The standard wiring attachments consist of a short length of small tubing bent to the form of a quadrant or semi-circle (as required), and welded into the corners of cellules (see Fig. 5). The bracing wires are looped round these attachments, doubling back upon themselves, thus functioning as a single wire of double length. Splices are dispensed with, but beyond that nothing good can be seen in this method of wiring, which is heavy and very weak, as its "fixing strength" is that of a wire doubled round a small diameter pin in place of twice that strength as is obtained by splicing.

The use of welding in the building up of the body also appears to be a weak feature. Vibration and reversal of stress cannot be taken adequately by such a structure. The corner attachments are somewhat reminiscent of the well-known Short U-bolt. The U-bolt had the standardization advantages of the Fokker fitting, and, in addition, without further sacrifice in weight, was a far more reliable and robust wiring attachment.

Summary of Constructional Criticism.—On broad lines little good can be said of the Fokker structure. The designer appears to have employed considerable ingenuity (or exhibited considerable mental slackness) in devising schemes whereby slight increase of manufacturing speed has been purchased at the price of grave structural weakness or increased weight.

Where speed of production has not tempted him, his aim has been reduction of resistance. Here also, strength—and above all, permanence of structural rigidity—has been disregarded, and yet it is hard to see what notable gain of "fineness" has been attained.

Wing Tip Skids.—These are rigidly-fixed ash skids located under the wing struts. The reason for fitting them is obscure, as they can only come into play as a result of an appallingly poor landing, and if they did come into play, would certainly buckle the flimsy interplane struts.

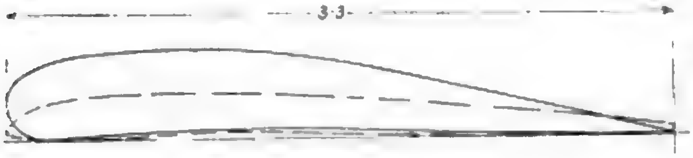

Fig. 4

Aerodynamical Features.—Certain of these features have been mentioned already. In this respect also, the design shows evidence that it has been carried out hastily and in a slovenly manner. There are signs of considerable ingenuity, but they are often marred by lack of broad consideration.

Wing Design.—Here, for instance, we have the elimination of external wiring. The "wireless" machine is not a new idea; many constructors have realized its good points—namely, the saving of wire resistance, and the diminution of tuning-up troubles. The Fokker designer has missed the counterbalancing defects, and his method of attack has led him into two grave faults. In the first place, the cantilever construction adopted is not only weak, but essentially non-rigid. The deformation under maneuvering stresses and the consequent variations of aerodynamical load-distribution would appear to render the problem of controllability curiously complicated.

Further, the high cambered section of the aerofoils cannot but counteract the slight advantage due to the saving of wire resistance. Experience has shown that "low lift" aerofoils cannot be beaten for use on scouts, and that whatever advantage in climb and altitude-flying capacity may be attained by the use of "high lift" sections is canceled and far more than canceled by the excessive horsepower required at fine angles of attack. When one considers the triplane effect (especially on small gap) which must, from first principles, obtain with such a deeply-cambered section the inefficiency of the main planes becomes evident.

Fig. 4 shows the amazing contrast between the Fokker section (full line) and R. A. F. 15 (dotted line), which may be taken as typical of British practice for similar machines.

Controls.—All control surfaces are balanced, but the method of balancing is inferior to that employed on the Albatros.

Ailerons are fitted to the top plane only, a type of construction which has been shown to be inefficient.

Engine.—The machine exhibited in the Aircraft View Rooms in London has no engine, but information received from overseas states that the engine is an Oberursel, very similar to the 110 h.p. Le Rhône. In fact, it is understood the only differences are slight points of detail design and the relative poverty of general finish. For instance, the nose piece is in two portions, the propeller shaft being separate from and bolted to the front plate of the engine.

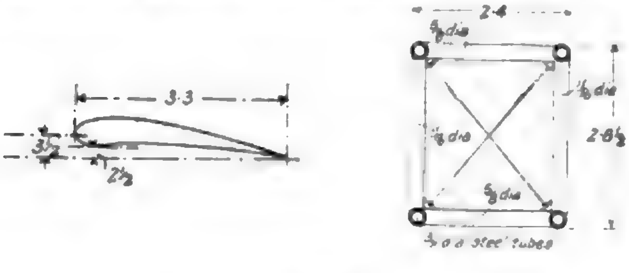

Fig. 5

The carbureter is a French-made Tampier bloctube, presumably obtained from a captured machine.

The oil pump appears to be a German copy of the standard Le Rhône oil pump. The magneto is a Bosch.

Armament.—Two Spandau guns are fitted, firing forward through the propeller, and fitted with synchronizing gear of the direct flexible drive type, a pinion on the flex shafting engaging with the gear wheel which meshes with the magneto and oil pump drives.

The guns are controlled by Bowden wires, from thumbpushes on the control lever. Three pushes are fitted, two for firing the guns independently and the third for simultaneous control.

Identification Marks.
R.F.C. No. G.125.
Maker No. 1856.
Military No. FOK. D.R.I. 144/17.
Date of construction, Nov. 20, 1917.

Weights (as stenciled on Machine).
Weight, empty .... 376 kg. — 829 lbs.
Permissible load (including fuel)........... 195 kg. 430 lbs.
Total weight .... 571 kg. = 1,259 lbs.

Weight of Engine.
334 lbs., including hub, magneto, oil pump and carburetor.
(Note.—Weight of 110 h.p. Le Rhône is 330 lbs.).

Tank Capacity
Petrol, 16 gallons } approximate.
Oil, 4 gallons }
(approximate duration 2½ hours at 10,000 ft.)

From the above it is possible to construct the following approximate weight analysis:
Fuel, oil and tank, 170 lbs. (allowing tank 18 lbs.).
Crew, 180 lbs.
Military load, 98 lbs.
Engine and propeller, 358 lbs. (allowing propeller 24 lbs.).
Structure, 453 lbs. (including engine bearers and instruments).
Structure percentage, 36.
Surface of main planes 205 sq. ft. (approximately).
Estimated B.H.P. (by analogy with 110-hp. Le Rhône)—113
lbs. per sq. foot 6.14.
lbs. per B.H.P. 11.15.

Flying Through Clouds

When flying in a cloud which obscures the horizon, says *Flight*, it is very difficult for a pilot to tell whether or not his machine is on an even keel. It is true that he will be able to tell from his speed indicator whether he is flying level or along a sloping path, but if at the same time the machine is making a turn, this is difficult to "feel," as it may be very slight. The compass should, theoretically, indicate a turn, but what frequently happens is this: A machine enters a cloud and the pilot watches his compass and speed indicator to see if he is keeping on his course. He then notices that the compass needle begins to move, and rudders in the opposite direction to check the turn.

As he can see nothing except his machine, the horizon being invisible through the clouds, he is very apt to overcorrect, with the result that the machine begins to turn the other way. The rudder is then put over in the opposite direction, and very likely overcorrection again occurs. In this way the machine swerves from side to side, each turn being accompanied by a bank. If this bank becomes steep the machine will probably get her nose down and the speed indicator will register a high velocity. As the pilot may not be aware of the amount of bank, he will instinctively pull his control lever towards him in order to pull the machine out of the nose dive. If the machine is steeply banked the elevators will not "flatten out" the machine, since they are in a position somewhere near the vertical and therefore act as rudders. The compass continues to swing, and before long the pilot may not have the slightest idea of what is really happening to his machine, until he emerges from the cloud.

The French Aerial Operations in 1917

The following table, compiled by Jacques Mortane for *Aeronautics*, gives a detailed survey of the activity of the French Air Service in 1917.

	German Airplanes Brought Down				Bombing Raids (weight of bombs dropped, lbs.)	
	In the French Lines	In the German Lines	Seriously Damaged	Kite Balloons	By Day	By Night
January	7	28	20	..	.....	38,770
February ...	7	16	13	1	.....	67,070
March	11	38	23	..	1,580	56,500
April	14	51	85	8	880	50,130
May	18	78	118	2	17,100	167,700
June	9	52	39	4	10,000	122,360
July	8	30	40	2	17,600	127,800
August	3	53	59	4	20,660	91,180
September ..	7	60	80	2	64,290	302,720
October	15	27	61	3	40,600	125,160
November ..	2	15	17	..	20,000	16,630
Dec. (1 to 15)	16	21	28	1	41,300	47,360
Total	117	169	583	27	284,710	1,208,330

News of the Fortnight

Inauguration of the Air Mail

The inauguration of the regular air mail service between Washington, D. C., and New York took place, as scheduled, on May 15.

Although no formal ceremonies attended the inauguration of the service, there was a large gathering of officials at both terminals. Among those present at the Washington terminal were the President and Mrs. Wilson, Postmaster General Burleson, Secretary of the Navy Daniels, Assistant Secretary Roosevelt, Major-Gen. W. L. Kenly, Director of Military Aeronautics, and representatives of the Aircraft Board, the National Advisory Committee for Aeronautics and the Senate and House Committees on Post Offices and Post Roads.

The machines used for this service were Curtiss biplanes fitted with 150 hp. Hispano-Suiza engines.

Since then the air mail has functioned with a sufficient regularity for so novel an undertaking to hold out favorable prospects for such additional air lines as may be organized in the future.

Two postal airplanes of a more powerful type, fitted with Liberty engines, have since been placed in service, and one of these machines flew on May 23 that day from Philadelphia to New York in 52 min., beating the best previous time by 23 min.

"The success obtained in operating the airplane mail service," said Postmaster General Burleson on May 29, "exceeds what I expected of the new route during its initial stages. The army has rendered a splendid service, which is not only a distinct contribution to the commercial world, but is proving valuable training for the aviators who are about to enter upon a greater task in France."

Billion and Quarter for Aeronautics

Nearly a billion and a quarter dollars for aeronautics is carried in the Army and Navy appropriation bills for the fiscal year ending June 30, 1919, which is now before Congress.

The Army appropriation bill provides $990,250,812.77 for the Signal Corps, including its now divorced Aviation Section. The report accompanying the bill shows that on May 16, 1918, the Signal Corps, including the Air Service, was made up of 13,343 officers and 121,746 enlisted men.

The Aviation Section of the Signal Corps, according to the testimony before Congress, is as follows: Number of officers, 12,107; number of enlisted men, 136,761; number of fliers, 4,054; number of machines in France, 1,316; number of machines in the United States, 3,760; number of combat machines in France, 323; and the number of aviation training camps in the United States, 27. It is reported to the committee that enlistments in the Aviation Section of the Signal Corps had become so rapid that the department had to put a stop order on the same. While it has been generally rumored that we had no airplanes with our forces in France, the fact is there are 1,316, of which 323 are combat or fighting machines.

In the naval bill $220,383,119 is carried for aeronautics, as passed by the Senate, while the original appropriation, as passed by the House, was $188,042,969. An appropriation of $100,000 is made for improvements to the naval air station at Pensacola, Fla., and the House appropriation of $150,000 is increased by the Senate to $200,000, for the acquirement of the remainder of Parris Island, Port Royal, S. C.

Air Service Association Is Formed

The increasing importance of the Air Services as an arm of reconnaissance and offense, and the growth of independent professional ideals and theories among the flying officers, have just been given expression in an organization known as the Air Service Association.

The purpose of this Association, as appears from its provisional constitution, is to unify all branches of the Air Service; to promote *esprit de corps;* to act as a clearing-house for ideas on mechanical improvements, method of training and aerial tactics; and to control a publication for the dissemination of news and information of benefit to the service.

The Association has been approved by Major-Gen. William L. Kenly, Director of Military Aeronautics.

The Association came into being as follows: On the evening of April 2, the officer commanding at Gerstner Field, Major M. Kirby, A. S. S. C., presided at a meeting of flying officers, who unanimously approved the suggestion put forth of forming a service association of their own along lines of similar Army and Navy organizations, and to be made up of the commissioned personnel of the Air Services.

Temporary officers were nominated and elected, and a committee appointed to draft a constitution and by-laws. This was followed on April 5 by the adoption of a temporary constitution and by-laws.

Communications have been addressed by the secretary to officers of the Army and Navy Air Services abroad, and to commanding officers of flying fields and air stations throughout the country, requesting them to bring the Association to the attention of all flying officers. The replies received indicate that officers are enthusiastically responding to the invitation to join the Association.

In July the election of permanent officers and the Board of Governors will take place, and the constitution and by-laws will be submitted to the first annual meeting for ratification or change as desired by the members.

The Air Service Association is a non-political organization, and is organized solely in the interests of the Air Services *as a whole.* Its tenets, beliefs and opinions will be expressed in the AIR SERVICE JOURNAL, which has been selected as the official journal of the Association, which will also publish such articles by members of the Association as are approved by an editorial staff to be appointed by the Board of Governors from the regular and honorary membership.

The initiation fee is ten dollars, and includes a year's subscription to the official journal of the Association. No dues will be collected.

Officers of the Army and Navy Air Services should send their applications for membership and initiation fee direct to Capt. William J. Malone, A. S. S. R. C., Secretary, A. S. A., Gerstner Field, Lake Charles, La.

Naval Aviators Wanted

The Naval Reserve Flying Corps has again been opened for applications to civilians and members of some branches of the Naval Reserve. It has been generally understood that applications from civilians would not be received, but an additional opportunity is now given to them. Applications should be addressed to Capt. Noble E. Irwin, Supervisor, Naval Reserve Flying Corps, Navy Department, Washington, D. C.

Marine Corps Enlists Aviators

A big drive is now on in recruiting men for the Aviation Section of the Marine Corps. Special efforts are being made to enlist college men and clean-cut, aggressive, quick-thinking and fearless athletes. Applicants who may have failed in regular Army and Navy Aviation will be considered.

For this purpose a personal campaign among the colleges of the country is being conducted by representatives of this Corps. They consist of privates and officers, all of whom are college men themselves. The results are very satisfactory.

Student aviators will be enlisted as gunnery sergeants and sent to the Massachusetts Institute of Technology, Cambridge, for ground work. The course there covers ten weeks. Thence they will be sent to Parris Island or some other station for training in flying. The time for this instruction has been reduced to eight weeks.

Signal Corps Wants News Photographers

A number of high-grade news photographers are urgently needed by the Signal Corps. These men must have expert experience in the handling of speed cameras such as Graflex and Graphic, and also understand speeds of lenses and various makes of cameras and operation of same.

Only those men who can furnish reference as to their actual experience as news photographers will receive consideration.

The men selected for this branch of the service will be sent to a school for military training. Upon completion of the training they will be promoted to grades of Sergeant, First Class, and will be ordered overseas in a short time.

Applicants must be citizens of the United States between the ages of 21 and 31. All communications should be addressed to Air Division, Training Branch, Photographic Section, Signal Corps, Washington, D. C.

To Protect Inventors

A bill creating a war inventions board to assist American inventors in developing devices which would be of value to the Army or Navy in winning the war is being drawn up by the American Inventors' Association of Washington, D. C., and probably will be introduced in Congress in the near future.

"The association will exert all of its energies to secure the passage of legislation creating a war inventions board to consist of five members, whose duty it shall be to seek, receive, inquire into and assist in the development of inventions of possible military value, the said board to be non-partisan and to be compensated by and under the Government," reads a statement approved at a meeting of the association on May 9.

F. J. Hemen, president of the association, said the bill probably will provide that this board shall protect the patent rights of devices laid before it, so that it will not be necessary to file the plans as public property in the Patent Office.

Wright-Martin Buys G. V. C. Plant

The Wright-Martin Aircraft Corp. has bought for more than $1,000,000 the General Vehicle Co.'s plant in Long Island City, according to press reports. The property consists of a six-story and a two-story building and other smaller structures in a plot bounded by Starr and Borden avenues and Fox and Beaver streets. It has a connection with the Long Island Railroad. It is said that the aircraft corporation has a contract to make for the Government 3,000 motors of 300 horsepower each, which it will manufacture in its new factory. Between 500 and 600 men are employed in it now, and the corporation intends to increase its force of mechanics and apprentices until it is 8,000 men, the capacity of the plant. The work of building the motors will be rushed in order to have them ready for the Government's airplane program.

Alexandria Aircraft Corp. Formed

Capt. A. W. Briggs and J. J. Rooney have resigned as general manager and chief engineer, respectively, of the Briggs Aeroplane Co., Alexandria, Va.

The business style of the company has been changed to the Alexandria Aircraft Corp. Blaine Elkins continues as president, and John W. Fenton, Jr., as secretary and treasurer. W. L. Bonney, who was purchasing agent, succeeds Captain Briggs as general manager. Webb C. Artz is business manager. The reorganization took effect on May 15. The factory of the new company remains in the old Portner brewery building, Alexandria.

On the same date the Briggs Aeroplane Co., of which Capt. A. W. Briggs is the head, was incorporated under the laws of the State of Virginia. The company has leased the Pioneer Mills property in Alexandria. To our Washington representative Captain Briggs stated on May 13 that this company plans to have its first machine ready for flight in about five weeks.

U. S. to Test Gasoline Substitute

Government tests of a gasoline substitute, which the inventor, Dr. Louis Clement, says can be manufactured for 8 cents a gallon, will be made in a few days at Pittsburgh. Gasoline substitutes presented for tests to date have fallen short of claims made by inventors, and Government experts have become skeptical that a powerful explosive gas can be made more cheaply than the gasoline refined from oil.

Fire Protection for War Plants

To minimize the possibilities of fires in munitions plants and all factories engaged on war work, the War Industries Board on April 9 created a fire protection section, which will maintain a close inspection of all plants engaged on Government work.

It will be assisted by the intelligence bureaus of the Army and Navy, and all local and district fire inspection services in the country. Where circumstances warrant, it will also enlist the aid of the fire marshals of the various States, and ask the cooperation of insurance underwriters.

Marines Can't Become J. M. A.'s

Following is a digest of a recent decision of the Judge Advocate General:

A member of the Marine Corps detached for service with the Army is not, under the national-defense act, eligible for detail in or attachment to the Aviation Section of the Signal Corps, and therefore cannot receive the rating of junior military aviator.

Newspaper Correspondent Reports on Production

David Lawrence, a Washington correspondent for the New York *Evening Post*, has recently made a survey of the production of some of the aircraft and engine factories. Among other places that he visited were Dayton, Detroit, Buffalo and Elizabeth.

At Elizabeth, Mr. Lawrence was received by Harry Bowers Mingle, president of the Standard Aircraft Corp. and the Standard Aero Corp. who is known to carefully guard as secret the important work that his plant is doing for the Government. Mr. Lawrence evidently did not obtain the basis for as good a "story" as he anticipated and "a feeling of disappointment" is reflected in his article that was published.

In this connection, Mr. Mingle has written the following letter to AVIATION AND AERONAUTICAL ENGINEERING which fully explains his position in the matter:

> "We have noted the article in the New York *Evening Post* of May 23rd relative to the work being done at the Standard Airplane plant. The writer had a personal conference with Mr. Lawrence, and stated to him that in our opinion the work which we are doing here is of a confidential nature, and that to date the production of both the Standard Aircraft Corporation and the Standard Aero Corporation has been satisfactory to the Government.
>
> "We have no apologies or explanations to make for the progress of our work and it is our belief that the results which this plant have obtained in production and in development speak for themselves, and that no statement other than this is advisable from a Government standpoint."

Aviation Fatalities Not High

The Secretary of War has authorized the following statement: The records of the Department show that from the beginning of training in June, 1917, to date the fatalities at military aviation fields in this country have been 51, viz.: 10 officers and 29 cadets killed in training flights, and 12 men killed in unauthorized flights and ground accidents.

Since the training of aviators began in this country, our student aviators have flown a total distance of considerably more than 100,000 miles. Considering the large number of men in training and the number of miles flown the fatalities have been remarkably low.

Taking into account the ordinary hazards of this occupation, the development of a comparatively new art, and the ratio of accidents in the everyday fields of endeavor, the fatality record among America's student aviators will compare favorably with those of other countries.

H. W. Johns-Manville Co. Branch to Move

The Houston, Tex., office of the H. W. Johns-Manville Co., will be located at 424 to 426 Washington Avenue, on and after July 1, 1918.

Glenn L. Martin Opens New Plant

The Glenn L. Martin Co., held a reception on May 29, the occasion being the opening of its new plant on St. Clair Ave., Cleveland, Ohio. Joseph A. Steinmetz, president of the Aero Club of Pennsylvania, addressed the invited guests.

Seaplane Emergency Ration

An emergency ration, consisting of one pound of brown bread, one pound of baked beans and one quart of water, for use on seaplanes, has been adopted by the Navy Department.

Whitman & Barnes Sales Changes

The following changes have been made in official positions in the Whitman & Barnes Mfg. Co's. sales department:

A. B. Hall, vice-president of the Whitman & Barnes Mfg. Co., will have supervision of the company's sales. He has for twenty years been connected with the company in various official capacities. His early connections were with the company's Chicago sales office as manager, which position he held until his transfer to the general office at Akron.

R. S. Carter, district representative of the company, with headquarters at Pittsburgh, has been promoted to sales manager and will have direction of twist drill and reamer sales from the Akron general office.

H. E. Fisher, formerly with the Pittsburgh Model Engine Co., Pittsburgh, Pa., has become associated with the Whitman & Barnes Mfg. Co., Akron, Ohio. He succeeds R. S. Carter as mechanical engineer and will have charge of sales in the Pittsburgh district.

Paul E. Thomas of Chicago, for years in the railroad circles in the traffic department of the Seaboard Air Lines has become connected with the Whitman & Barnes Mfg. Co., Akron.

JUNE 15, 1918

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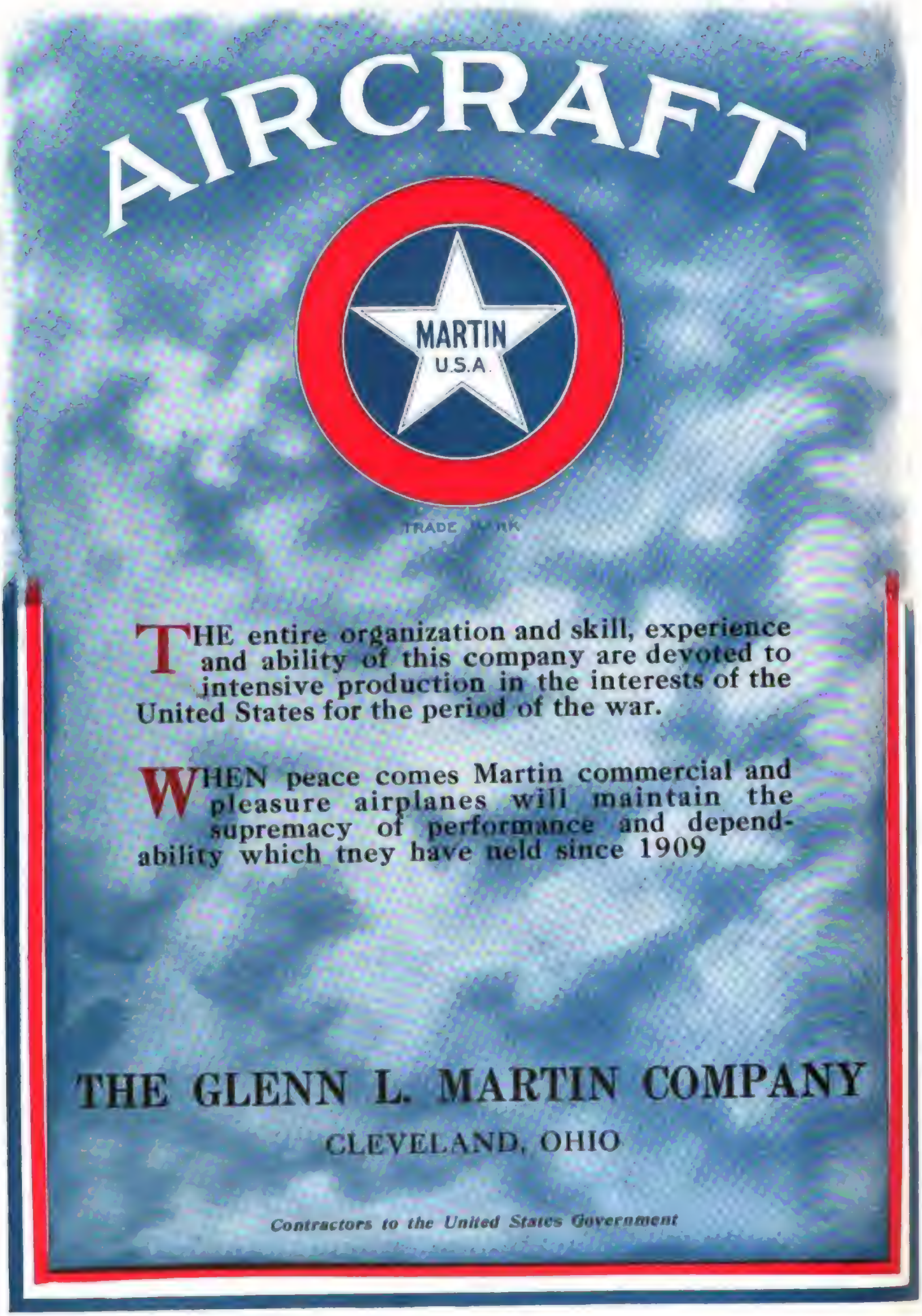

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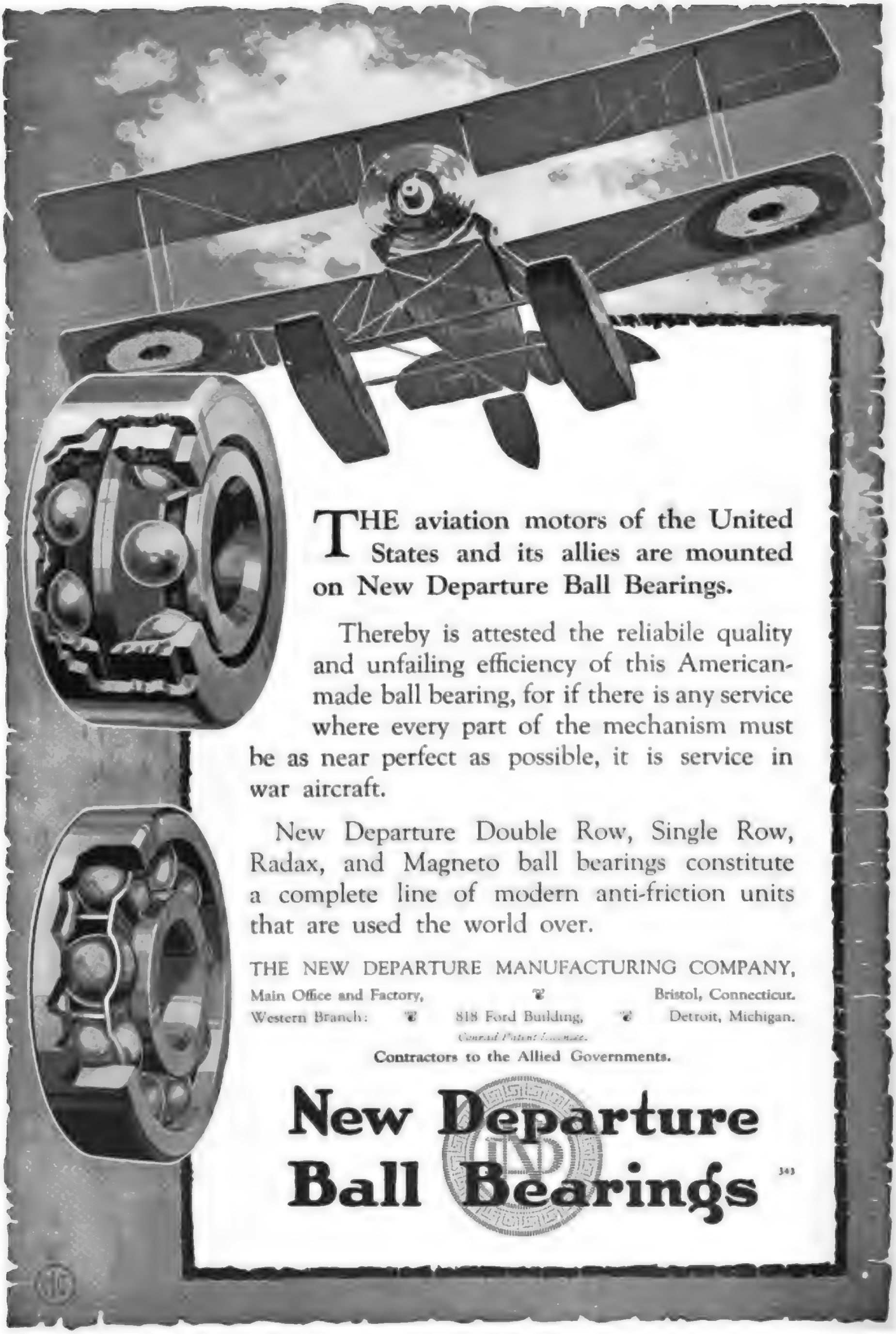

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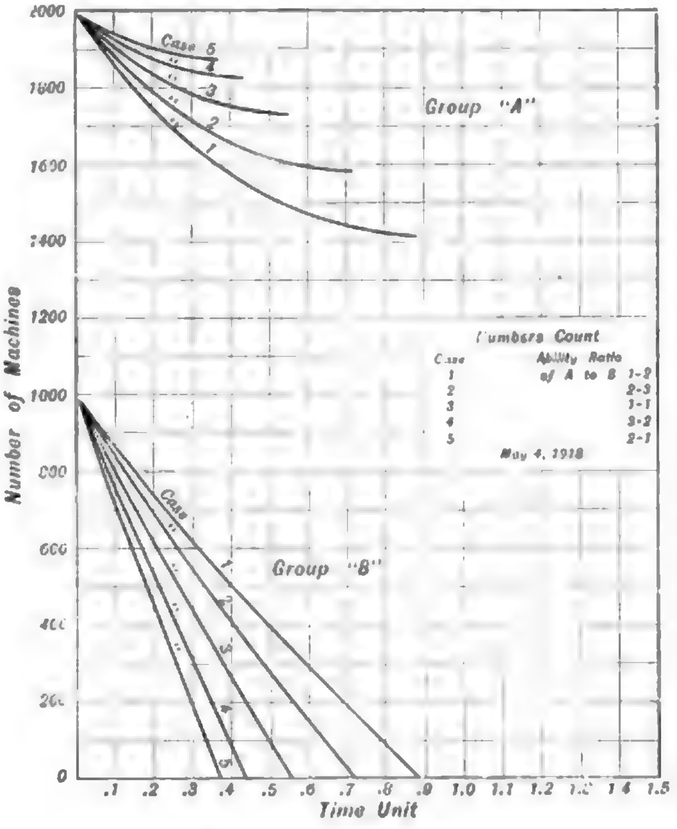
Vol. IV June 15, 1918 No. 10

Importance of Numbers in Aerial Warfare

By Dr. J. G. Coffin and H. T. Booth

The Curtiss Engineering Corp.

The English pioneer in the science of aeronautics, F. W. Lanchester, has several chapters in his book, "Aircraft in Warfare," which merit far more attention than they have yet received. The book teems with predictions written during the period immediately following the outbreak of hostilities, September to December, 1914, which by now have been borne out in a most complete and astonishing fashion.



Graph Showing Value of Quantity

Two chapters on the effect of concentration are especially interesting when applied to aerial warfare, and they point the way quite clearly toward aerial supremacy. The results are given without demonstration, and partially on this account, as well as on account of the intrinsic information therein contained, the present article seems to us to be not without interest, especially at the present time.

The devising and building of a new type of airplane which has "quality" superiority over the best existing type is a slow, difficult and costly process. The emphasis is on the word "slow." Time is precious just now, and an important question immediately arises: By what factor can "quality" be overcome? The answer is conclusive; it is "number" or "quantity." We do not deny any advantage derivable from quality, but quantity is at once obtainable.

There are in existence today a number of very efficient fighting machines of the different types. Any new "quality" which can conveniently be incorporated in the machines is, of course, an added advantage, but, as the article shows, the superiority of quantity is overwhelming.

In the past when fighters met man to man, it was seldom that many concentrated upon one; superiority in numbers was almost in direct proportion to the numbers themselves; the losses were about equal, under conditions equal except as to numbers, and the more numerous won on that account alone.

"Nowadays," writes Lanchester, "with firearms, the possible concentration of superior numbers gives an immediate superiority in the active combatant ranks, and the inferior force finds itself under a far heavier fire, man for man, than it is able to return."

We have made some calculations of our own based on an assumption stated very clearly by Lanchester. His statement amounts to the following: The rate of mortality in one group of fighters is directly proportional to the numbers (and to the quality) in the opposing group, and vice versa. The results of this assumption are certainly at first sight astonishing. While no one claims that battles are fought which result in an exact agreement with the calculated results, the general principle is so definite and convincing that its approximate validity cannot seriously be questioned.

Lanchester says: "There are many who will be inclined to cavil at any mathematical or semi-mathematical treatment of the present subject on the ground that, with so many unknown factors, such as the morale or leadership of the men, the unaccounted merits or demerits of the weapons, and the still more unknown 'chances of war,' it is ridiculous to pretend to calculate anything. The answer to this is simple: the direct numerical comparison of the forces engaging in conflict or available in the event of war is almost universal. It is a factor always carefully reckoned with by the various military authorities; it is discussed *ad nauseam* in the press. Yet such direct counting of forces is in itself a tacit acceptance of the applicability of mathematical principles, but confined to a special case. To accept without reserve the mere 'counting of the pieces' as of value, and to deny the more extended application of mathematical theory, is as illogical and unintelligent as to accept broadly and indiscriminately the balance and the weighing-machine as instruments of precision, but to decline to permit in the latter case any allowance for the known inequality of leverage."

Assume two groups of fighting airplanes, each group of any ability or excellence. The first group "*a*" in number and the second group "*b*" in number. We shall denote the quality of the two groups by the numbers *A* and *B* respectively. Then if x and y are variables representing the numbers in groups 1 and 2 respectively, at any time t, we may write the following equations:

$$-\frac{dx}{dt} = By \qquad -\frac{dy}{dt} = Ax \qquad (1)$$

These equations assume that the rate of decrease in the numbers of group 1 is proportional to the surviving numbers of group 2, and that the rate of decrease in the numbers of group 2 is proportional to the surviving numbers in group 1. The ability or quality of the two groups is included in the proportionality factors A and B.

Differentiating once and substituting from the original equations, we obtain:

$$\frac{d^2x}{dt^2} = ABx \qquad \frac{d^2y}{dt^2} = ABy \tag{2}$$

If we let $AB = \lambda^2$, the solution of these familiar equations may be written:

$$\begin{aligned} x &= C_1 \cosh \lambda t + C_2 \sinh \lambda t \\ y &= C_3 \cosh \lambda t + C_4 \sinh \lambda t \end{aligned} \tag{3}$$

It remains to evaluate the four constants of integration.

$$\begin{array}{lll} \text{When} & t = 0 & x = a \\ & t = 0 & y = b \\ \text{so that} & C_1 = a & C_3 = b \end{array}$$

Since

$$\frac{dx}{dt} = -By = C_1\lambda \sinh \lambda t + C_2\lambda \cosh \lambda t$$

$$-Bb = C_2\lambda$$

so that $$C_2 = -\sqrt{\frac{B}{A}}\,b$$

Similarly $$C_4 = -\sqrt{\frac{A}{B}}\,a$$

The general equations expressing the course of events then become:

$$x = a \cosh \lambda t - b\sqrt{\frac{B}{A}} \sinh \lambda t \tag{4}$$

$$y = b \cosh \lambda t - a\sqrt{\frac{A}{B}} \sinh \lambda t$$

The solutions are symmetrical functions of $\lambda = \sqrt{AB}$, hence in order to obtain results comparable on the time scale, we shall maintain constant the product AB as we vary A and B separately.

We shall assume throughout that $a > b$.

There are three cases of interest, namely:

$$A < B \qquad A = B \qquad A > B$$

For numerical computation let $a = 2000$ $b = 1000$.

We shall keep $\lambda^2 = AB$ constant and equal to 1, in which case the general equations are:

$$\begin{aligned} x &= a \cosh t - Bb \sinh t \\ y &= b \cosh t - Aa \sinh t \end{aligned} \tag{5}$$

CASE I

Let $A = \frac{1}{2}B$, hence because $AB = 1$, $A = .707$, $B = 1.414$.

The numerical equations are:

$$\begin{aligned} x &= 2000 \cosh t - 1414 \sinh t \\ y &= 1000 \cosh t - 1414 \sinh t \end{aligned}$$

When $y = 0$, that is when the enemy squadron is completely destroyed, $\tanh t = .707$ and $t = .881$ units. For this value of t, $x = 1413$. Hence while group 2 lost 1000 machines, group 1 lost 587 although group 1 had only half the ability or quality of group 2.

CASE II

Let $A = \frac{2}{3}B$ so that $A = .815$, $B = 1.224$.

The equations are:

$$\begin{aligned} x &= 2000 \cosh t - 1224 \sinh t \\ y &= 1000 \cosh t - 1633 \sinh t \end{aligned}$$

When $y = 0$, $\tanh t = .6125$ and $t = .713$ units.

For this value of t

$$x = 1581$$

Therefore, group 1 has totally destroyed group 2 with a loss of 419 machines only, just because of numerical superiority.

CASE III

Let $A = B$, equal quality, $A = 1$, $B = 1$

For this case

$$\begin{aligned} x &= 2000 \cosh t - 1000 \sinh t \\ y &= 1000 \cosh t - 2000 \sinh t \end{aligned}$$

When $y = 0$, $\tanh t = .500$ and $t = .55$ units

When $t = .55$

$$x = 1732$$

So that when the second group was totally destroyed, there remained 1732 machines in the first group, the net result being a loss of only 268 to the enemy's 1000.

CASE IV

$A = \frac{3}{2}B$, greater numbers, better quality $A = 1.224$, $B = .815$

$$\begin{aligned} x &= 2000 \cosh t - 816 \sinh t \\ y &= 1000 \cosh t - 2450 \sinh t \end{aligned}$$

When $y = 0$, $\tanh t = .408$ and $t = .433$ units

When t has this value

$$x = 1826$$

The first group suffered a loss of only 174 to 1000 of the second.

CASE V

$A = 2B$ $A = 1.414$ $B = .707$

$$\begin{aligned} x &= 2000 \cosh t - 707 \sinh t \\ y &= 1000 \cosh t - 2828 \sinh t \end{aligned}$$

When $y = 0$, $\tanh t = 0.353$ and $t = 0.370$ units

$$x = 1871$$

a loss of only 129 machines.

The following table summarizes the foregoing results:

	Group I.				Group II.			
	Initial Number 2,000.				Initial Number 1,000.			
	Ability. Ratio. A B	Final No.	Lost— Nos.	% loss.	Time.	Final No.	Lost.	
Case I	1 to 2	1,413	587	29.4	.881	0	1,000	100%
Case II	2 to 3	1,581	419	21.0	.713	0	1,000	100%
Case III	1 to 1	1,732	268	13.4	.550	0	1,000	100%
Case IV	3 to 2	1,826	174	8.7	.433	0	1,000	100%
Case V	2 to 1	1,871	129	6.5	.370	0	1,000	100%

The curves, delineated in the accompanying figure, show how the numbers fall off in the two groups after fighting begins. The curves belonging to group A, cease to have any meaning as soon as the corresponding curve of group B reaches zero.

This table shows conclusively that numerical superiority is the controlling factor in every case considered even with the quality factor against it. The first case is especially interesting in this respect where a number of machines fighting one half that number but of twice the quality win out with a loss of 30% as compared to a loss of 100% in the smaller group. With these equations it is, of course, possible to calculate the advantage to be derived by separating by superior strategy, the equally numerous enemy group into two groups, and separately annihilating them.

For example a force x of 1000 meets separately a force y of 500. The result is that the 500 are destroyed with a loss of only 134 in the x force. This leaves 866 x forces opposed to 500 new y forces which they can destroy with a loss to themselves of only 159 more, making a total loss in the x forces of only 293 against 1000 enemy forces.

Consider two unequal groups a and b and let us deduce the relation that must exist between the quality factors A and B, so that both groups lose simultaneously all of their machines, i.e., 100% loss.

The general equations give for this supposition

$$\begin{aligned} 0 &= b \cosh T - Aa \sinh T \\ 0 &= a \cosh T - Bb \sinh T \end{aligned}$$

where T is the time at which this occurs and the ratio of $\frac{B}{A}$ is to be determined. By dividing one equation by the other, we get immediately

$$\frac{B}{A} = \frac{a^2}{b^2} = \left(\frac{a}{b}\right)^2$$

In other words, in order to overcome a numerical superiority ratio $\frac{a}{b}$, the smaller group must have a quality better than the larger group as the square of that ratio. Specifically, to overcome a twice larger group, the quality of the smaller must be four times that of the larger. A superiority in numbers of three would require a quality superiority of nine and so on.

Lanchester's demonstration of this principle, which he calls the n^2-law is very neat and is given below. Our demonstration makes it a special case of the general integrated equations.

His assumption is that if two forces are engaged, their *relative* strength is unimpaired if the same fraction of both is simultaneously put out of action, that is

$$\frac{\frac{dx}{dt}}{x} = \frac{\frac{dy}{dt}}{y}$$

which, together with

$$-\frac{dx}{dt} = By \text{ and } -\frac{dy}{dt} = Ax$$

gives immediately $By^2 = Ax^2$

or, as he puts it, "the fighting strength of two opposing forces are equal when the products of the qualities by the square of the number respectively are equal."

The time T at which total destruction is completed is given by

$$\tanh T = \frac{a}{Bb} = \frac{b}{Aa}$$

Here, of course, it is necessary to know the absolute quality in order to compute specifically the time, but if the quality ratio is as stated above, both groups will eventually completely destroy each other.

It is of some interest to determine what the quality ratio should be in order that when the weaker group is annihilated, the stronger shall have lost the same number of machines.

The conditions for this case are, that when

$$b = T \qquad x = a - b \qquad y = b - b = 0$$

The equations become

$$a - b = a \cosh T - Bb \sinh T$$
$$0 = b \cosh T - Aa \sinh T$$

From the last we get

$$\tanh T = \frac{b}{Aa} = \frac{ABb}{Aa} = \frac{Bb}{a}$$

From the second

$$\frac{a-b}{a} = \cosh T - \tanh T \sinh T$$
$$= \frac{\cosh^2 T - \sinh^2 T}{\cosh T} = \frac{1}{\cosh T}$$

so that $\cosh T = \frac{a}{a-b}$

Since $1 - \tanh^2 T = \frac{1}{\cosh^2 T}$ we get, calling $\frac{a}{b} = Z$ the odds,

$$\frac{B}{A} = (2Z - 1)$$

So that, if the odds are 2 to 1 against the smaller group, it will, nevertheless, inflict an equal loss on the larger group if its quality is three times that of the more numerous group; if the odds are 3 to 1, it must have a superiority of quality 5 in order to destroy an equal number of machines.

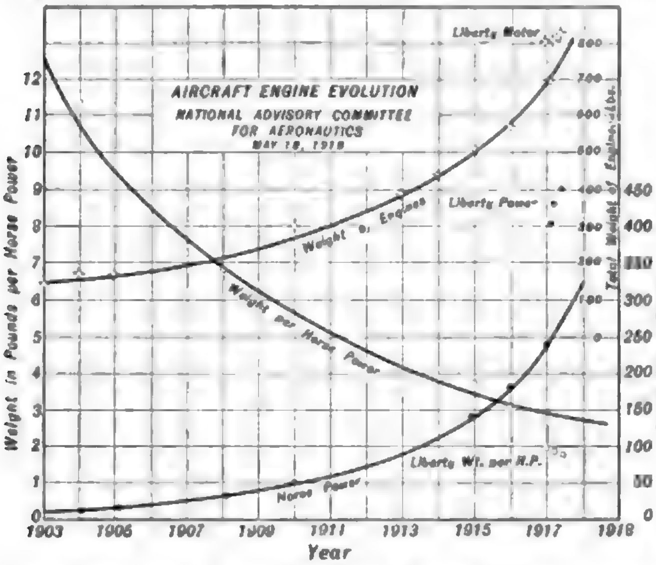
This case shows the conditions necessary where inferior machines are sacrificed for an equal number of better quality.

Although the treatment of the subject is slightly different from that of Lanchester, no claim of originality is made by the writers of this article who will feel gratified if it will attract attention to the fact so clearly brought out that "numbers" certainly do "count."

Evolution of the Airplane Engine

The War Department authorizes the following statement on the evolution of the airplane engine which has been prepared by the National Advisory Committee for Aeronautics:

The first man-carrying airplane flights were made in December, 1903, with the Wright Brothers' engine developing 12 hp. and weighing 152 lb., or 12.7 lb. per horsepower. In 1910, seven years later, the average horsepower of aeronautic engines had increased to 54 and the weight decreased to 5.7 lb. per horsepower. In another seven years, 1917, the average power output had advanced to 243 hp. and the weight decreased to 2.8 lb. per horsepower. In March, 1918, the Liberty twelve developed 432 hp. for a weight of 808 lb., or 1.86 lb. per horsepower. At the present time, May, 1918, the Liberty twelve is yielding a maximum of 450 hp. for a weight of 825 lb., or 1.83 lb. per horsepower.



The accompanying table and curve sheet show the advance in the average power-weight ratio by years for the engines in actual flying use. It is to be especially noted that the Langley-Manly engine, built in 1901, was nine years ahead of its time in the matter of power output and sixteen years ahead in its weight per horsepower.

In 1917, the Liberty "twelve" was sixty-five per cent more powerful and twenty-eight per cent lighter per horsepower than the average in service for that year. So far this year, these figures are probably changed to fifty per cent and twenty-five per cent respectively, which indicate the advance of the Liberty over the average engine in service at the present time.

AIRCRAFT ENGINE EVOLUTION

Name of Engine	Year	Horse Power	Weight (lb.)	Weight per hp.
Langley-Manly Engine	1901	52	151	2.9
Original Wright Bros.	1903	12	152	12.7
Improved Wright Bros.	1904	16	180	11.4
Improved Wright Bros.	1905	19	180	9.5
Redesigned Wright Bros.	1908	35	182	5.5
Average on Market	1910	54	309	5.7
Wolseley Engine	1913	147	720	4.9
Average on Market	1914	112	437	3.9
Average on Market	1915	133	512	3.8
Average on Market	1916	185	570	3.1
Average on Market	1917	243	693	2.8
Liberty 12 cyl.	1917	400	801	2.0
Liberty 12 cyl. (March)	1918	432	808	1.9
Liberty 12 cyl. (May	1918	450	825	1.8

The average consumption of fuel decreased from about .8 lb. per horsepower in 1903 to about .65 lb. in 1914, since which it has slowly dropped to .55 lb. in 1918, and, for the Liberty to .50 lb. The present Liberty consumption is approximately .46 lb. per horsepower/hour.

Illustrating the advance made, the Wolseley Company in 1913, could only obtain 147 hp. at 1400 revolutions per minute from eight cylinders, five in. bore by seven in. stroke, or 18.375 hp. per cylinder. This is the same size cylinder as used in the Liberty which now gives 450 hp., at 1800 revolutions, from twelve cylinders, or 37.5 hp. per cylinder obtained in the Wolseley. Even if we reduce the Liberty results to the same speed as the Wolseley, that is, 1400 revolutions, the Liberty still represents a great advance, for at that speed 350 horsepower are developed, or 29.2 hp. per cylinder. Moreover, the Wolseley weighed 4.9 lb. per horsepower as compared with 2.3 lb. for the Liberty at the same speed, or 1400 r.p.m.

[Editor's Note—While the above statement is quite interesting, it seems rather regrettable that the engines from which the "average on the market" from 1913 to 1917 has been compiled are not specifically mentioned, for this would greatly enhance the value of this table. One might also point out that the Wolseley engine, of which such a free use is made for purposes of comparison with the Liberty engine, cannot be called a representative of its period, for it was never currently employed on any type of airplane. One is also under the impression that the geared-down model of the Liberty twelve, developing 450 hp., was only an experimental type and will not be manufactured for use in service airplanes.]

The Friedrichshafen Bombing Biplane*

Forward Cockpit—This is attached to the main body by four bolts with clips similar to those earlier described. It consists of a light wooden framework, covered throughout by three-ply. This cockpit can be divided off from the main cockpit by means of a fabric curtain. Its occupant is provided with the folding seat, and manages a gun and the bomb-dropping gear.

Engine Mounting—The engine bearers have the section shown in Fig. 20, and are each built up of two pieces of pine united by tongues. On their top surface they are faced with ply wood and at the bottom with ash. A strip of ash applied to the upper outer corner of the bearer gives it an "L" section, and has screwed into it the threaded sockets for the set screws of the lower part of the engine fairing. The engine bearers taper sharply at each end. They are mounted on the "V" struts by means of acetylene welded brackets, constructed as shown in sketch, Fig. 21. These, it will be seen, are of box form, and form a liner round the streamline tube.

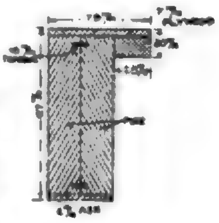


FIG. 20

The engine cowling is a particularly fine piece of work, and two views are given in sketches 22 and 23. The lower portion is attached to the engine bearers by set screws, but the upper part is readily detachable, being furnished with turn buttons. This cowling allows the cylinders of the engine to be exposed to the air. A large scoop is placed in front, so as to permit a free flow of air over the bottom and sides of the crank-chamber, while at the rear three large trumpet-shaped cowls are provided so that a draft of air is forced against the crankcase in the neighborhood of the carbureter air intake. In the rear the fairing abuts against the propeller nave, while in front it is attached to the radiator. It will be noticed that at each side of the radiator are narrow air scoops, the object of which is to promote a draft past the oil tank and front cylinder heads.

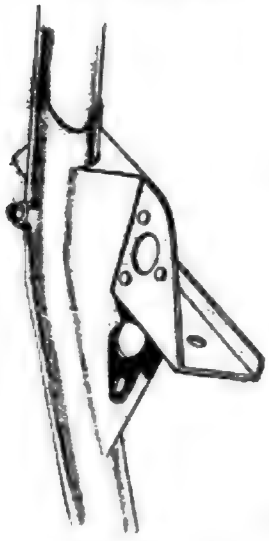


FIG. 21

Engines—The engines are the standard 260 hp. Mercédès, with six cylinders in line. Full details of this engine have been published, and it is only, therefore, necessary to notice one or two points in connection with the installation.

A new departure is the interconnection of the throttle and ignition advance controls. This is carried out in the manner illustrated diagrammatically in Fig. 24. It will be seen that a considerable movement of the throttle can be made independently of the ignition advance. In the Mercédès carbureter the throttle is so arranged that it cannot be fully opened near the ground without providing too weak a mixture, and it is thought possible that the full ignition advance is not obtained until this critical opening is reached.

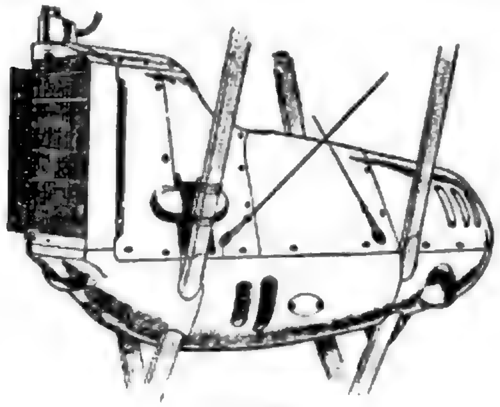


FIG. 22

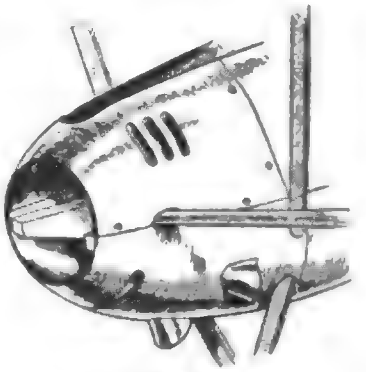


FIG. 23

On several German bombing airplanes grease pumps for lubricating the water pump spindle have been found. Fig. 25 shows the design as fitted to the Friedrichshafen. It consists of a ratchet and pawl operated grease pump, secured by a bracket to one of the engine struts, and worked from the pilot's cockpit by a lever, and a stranded steel cable passing over a pulley, the pawl being returned by a long coiled spring.

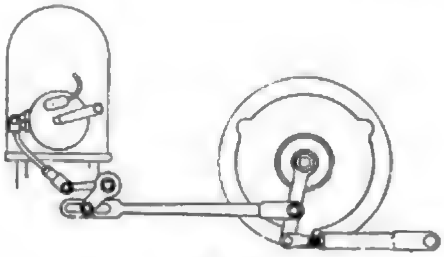


FIG. 24

The engine numbers are respectively MN.32209 and MN.36228.

The exhaust pipe is of new design, although it incorporates the well-known expansion joints attached to the flanges. It is fitted with what amounts to a rudimentary silencer, whereas in previous machines of a similar type to the Friedrichshafen an open-ended exhaust pipe was used.

Radiators—Each radiator is provided with an electric thermometer fitted into the water inlet pipe; these thermometers are wired up to a dial on the dashboard, which is furnished with a switch so that the temperature of either radiator can be taken independently. (Fig. 26.)

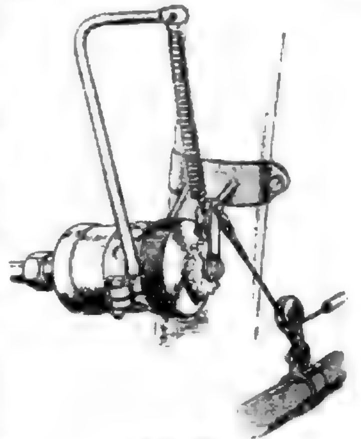


FIG. 25

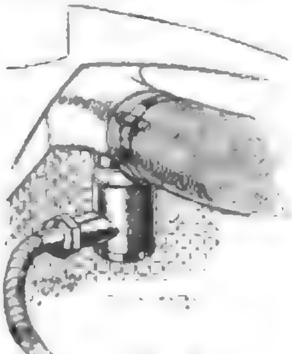


FIG. 26

The honeycomb radiators are of "V" section, and each is provided with a shutter, which covers up a little more than a third of the cooling surface. This shutter is fitted with a stop, so that when fully opened it lies in the line of flight of the airplane. It is opened or closed according to circumstances by the gear, shown in the sketch, Fig. 27, of which the handle is mounted on the roof of the nacelle, immediately behind the pilot's seat. Three positions are provided for the handle, which operates the two shutters simultaneously by means of return cables.

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* Concluded from the last issue.

Immediately above the main radiator, and let into the upper main plane between the front spar and the leading edge, is a small auxiliary tank. This is furnished with a trumpet-shaped vent in the direction of the line of flight, and is furnished with two outlets, one to the head of the main radiator and the other to the water pump. The function of this tank is evidently to prevent the pump from priming. (Fig. 28.)

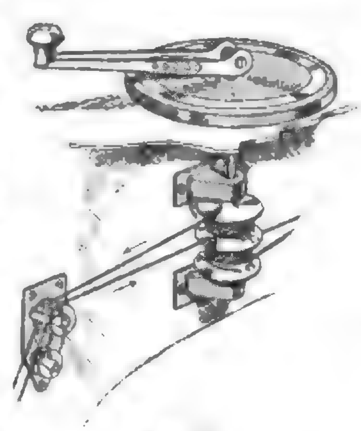


Fig. 27

Oil Pump—The main supply of oil is carried in sumps forming part of the base chamber. A secondary supply of oil, from which a small fresh charge is drawn at every stroke of the oil pump, is contained in a cylindrical tank supported by brackets from the engine struts and placed immediately behind the radiator. This tank has a capacity of 25 liters = 5½ gallons. Each tank is furnished with a glass level, which is visible from the pilot's seat.

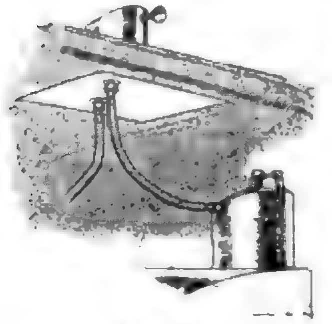


Fig. 28

Gasoline Tanks—The two main tanks, which are placed one under the pilot's seat and the other at the top rear end of the nacelle, contain 270 liters = 59½ gallons each, and are made of brass. Each is provided with a Maximall level indicator, which employs the principle of a float operating a dial by means of a cable enclosed in a system of pipes.

A hand pump is fitted convenient to the pilot, and pressure is normally provided by the pumps installed in each engine. An auxiliary tank, holding approximately 13 gallons, is concealed in the upper main plane, not immediately over the nacelle but a little to the left side. This auxiliary tank is fitted with a level, which is visible from the cockpit. The auxiliary tank appears to be used only for starting purposes. It is covered with a sheet of fabric held in position by "patent fasteners."

Engine Controls—Running from each engine to the nacelle is a horizontal streamline casing, containing the various engine controls. The leading edge consists of a steel tube, to which are welded narrow steel strip brackets, to the rear end of which are bolted thinner strips which are hinged in front to the tube. The whole is then enclosed in a sheet aluminum fairing.

Through the leading tube passes the throttle control rod for each engine, the two throttles being worked either together or independently by the ratchet levers, shown in Fig. 29. These are mounted on a shelf convenient to the pilot's left hand. This control requires a considerable number of bell cranks and countershafts, but was noticeably free from backlash. The throttle is opened by the pilot pulling the levers towards him.

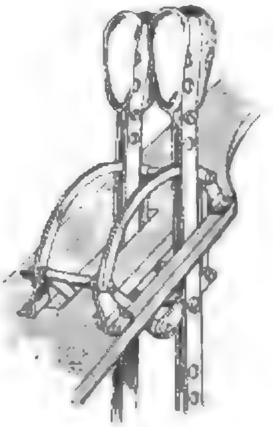


Fig. 29

On the dashboard are two revolution counters and two air pressure indicators. The metal parts of these dials are painted red for the left engine and green for the right, and the same coloring applies to the magneto switches, one of which contains a master switch which applies to both magnetos on both engines.

Piping—The various systems of piping are distinguished by being painted different colors; thus the petrol pipes are white, arrows being also painted on them to show the direction of flow; air pressure pipes are blue and pipes for cable controls grey.

Propeller—The propellers are made by the Luckenwalde Propellerwerke, Niendorf. Each propeller is 3.08 meters in diameter and is made of nine laminations, which are alternately walnut and ash, except one which appears to be of maple, the last 20 in. of its blade is edged with brass. The pitch is approximately 1.8 meters and the maximum width of the blade 220 millimeters.

Controls—Only one set of control gears is fitted, but, as pointed out, the seating accommodation is so arranged that any of the crew can take charge if and when necessary.

The elevator and aileron control is shown in sketch Fig. 30. It consists of a tubular steel pillar mounted on a cranked cross bar at its foot. The ailerons are worked by cables passing over a drum on the wheel, whence they descend through fiber guides on the cross bar to another wheel mounted on a countershaft below, from which they are taken along inside the leading edge of the lower wing and finally over pulleys up to the aileron levers on the top plane. The latter are partially concealed in slots let into the trailing edge of the wing. The upper and lower ailerons are connected by means of pin jointed tubular steel struts of streamline section.

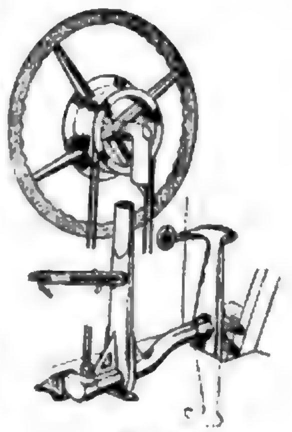


Fig. 30

It will be observed from Fig. 30 that a locking device whereby the elevator control can be fixed in any desired position is fitted, and consists of a slotted link which can be clamped by a butterfly nut to the control lever. This link is hinged to a small bracket attached to the panel below the pilot's seat.

Fig. 31 shows the rudder control, from which cables are taken over pulleys and through housings in the nacelle and finally to the end of the fuselage. The crank rudder bar is of light steel tube, and is arranged to be placed in the pivot box in either of two positions. It is furnished with light steel tubular hoops, which act as heel rests and are adjustable. A locking clip is fitted on the floor of the cockpit so that the rudder can be fixed in its neutral position.

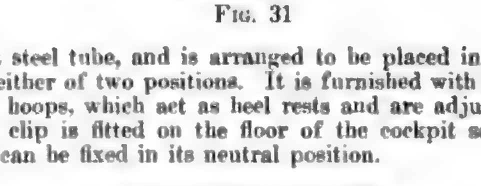


Fig. 31

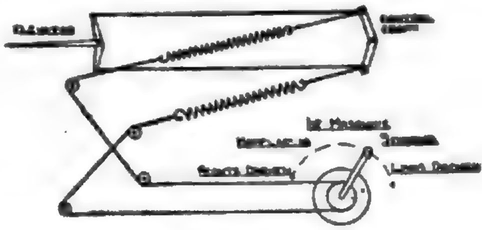


Fig. 32

A novel type of trimming gear is an interesting item of the control. Movement of the elevator control from the normal upright position of the stick is made against the tension of one of two springs which can be alternately extended and relaxed by means of a winch connected to them, as shown in the diagram, Fig. 32. Normally these springs tend to bring the control stick back to a central position, in which the elevator lies flat, but if one of the springs is tensioned by winding up the winch in a clockwise direction, the position to which the stick will tend to come when released will be such as to set the elevator at a positive angle. This winch gear, which is illustrated in Fig. 33, is mounted on the right-hand side of the nacelle, and is therefore under the command of the pilot's companion.

The crank is furnished with a locking pawl, which engages with a ring of small holes bored in the plate of the winch. The steel springs used in conjunction with this apparatus are some 3 ft. long and about ¾ in. in diameter. The inscription behind the winch reads:

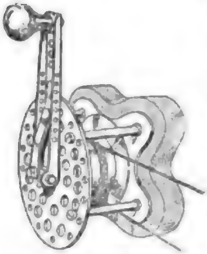


Fig. 33

Nose heavy—Right wind.
Tail heavy—Left wind.

Landing Gear—As might be expected, the landing gear on this machine is of massive proportions. Two vertical streamline section wood-filled tubes descend from the center section wing spars, immediately under the engine, to a bridge piece or hollow girder made of welded steel. This is shown in Fig. 34. Through an oval hole in this girder a short axle carries two 965 × 150 mm. wheels (38 in. × 6 in.). These work up and down against the tension of a bundle of steel springs about ½ in. in diameter and made of wire approximately 1/16 in. thick. The steel girder is extensively pierced for lightness, and the edges of the holes are swaged inwards. The axle is prevented from moving sideways by plates, and is provided with short steel cables which act as radius rods and connect it to the front of the girder. The whole of the box girder is covered in with a detachable bag of fabric, which extends up to the small cross bar mounted immediately above the girder.

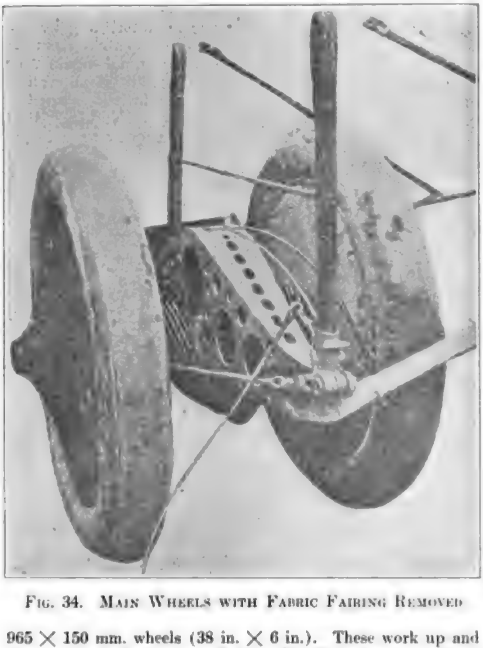


Fig. 34. Main Wheels with Fabric Fairing Removed

Mudguards are provided behind each landing wheel for the purpose of preventing any mud or stones dislodged by the wheels from coming in contact with the propellers.

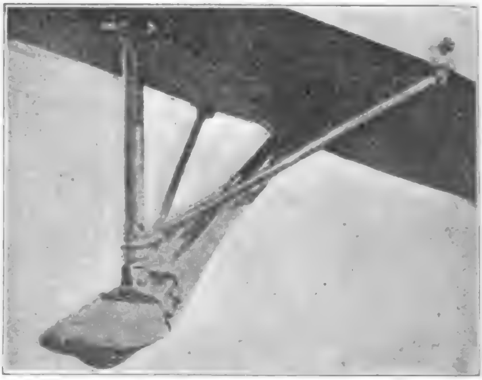


Fig. 35. Tail Skid

From the front and rear of the box girder streamline tubes are taken to the ends of the main wing spars, where they abut against the nacelle, and these diagonals are further braced with streamline steel tubes. Both the vertical and diagonal tubes are held in split sockets so as to be easily replaceable if damaged.

In addition to the four main landing wheels a fifth is mounted under the nose of the fuselage. This wheel is 760 mm. × 100 mm. (30 in. × 4 in.) It is mounted on a short tubular axle, which is capable of sliding up and down slots in its forks against a strong coil spring, and it is also capable of a certain amount of lateral movement along its axle, also against the action of two small coil springs.

The tail portion of the body is protected by a fixed skid made of wood but shod with a steel sole. This is arranged as shown in photograph Fig. 35, and is fitted with a small coil spring contained inside the body.

Wiring—The whole of the wiring system on the machine is very neatly carried out. There are three main systems: firstly, the ignition wiring, which is contained for the most part in tubes of glazed and woven fabric; secondly, the heating system, for which the wires are carried in flexible metal conduits; and, thirdly, the lighting system, in which a thin celluloid protective tubing is used. Wires are run from the nacelle along the leading edge of the upper planes to points level with the outermost strut. Here they terminate in a plug fitting placed behind a hinged panel. Apparently lamps are intended to be served by this circuit. Immediately in front of the pilot's seat a universally jointed lamp bracket is mounted on the outside of the nacelle. The exact purpose of this lamp is not known, as it could not illuminate any instruments.

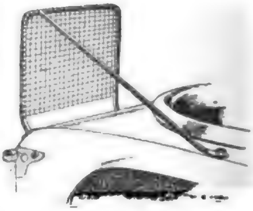


Fig. 36

Armament—Both the forward and rear cockpits are furnished with swivel gun mounts carrying Parabellum machine guns. These mounts consist of built-up laminated wood turntables working on small rollers, and carry a U-shaped tubular arm for elevation. This arm is hinged to a plunger rod working through a cross head, and arranged so that the arm is normally pulled down flat on the turntable by a coil spring. The plunger can be locked in any of a series of positions by means of a bolt operated by a hand-lever through a Bowden wire. A second lever allows the turntable to be locked at any desired point. A perforated sheet-metal shield protects the cross head and spring. Small shoulder pads are fixed on the turntables; of which that in the forward cockpit has a diameter of 2 ft. 10½ in., whilst in the rear the diameter is 3 ft. 0½ in.

The after-gunner is prevented from damaging the propellers by two wire netting screens supported by tubular steel brackets, placed on either side of his cockpit. (Fig. 36.)

In addition to these two guns, provision is made for mounting a third in front of, and to the right of, the pilot's cockpit, where it could be managed by his companion. For this purpose a clip is provided immediately under the coaming of the nacelle, and the handle of this protrudes through a slot in the dashboard. The clip works on the eccentric principle, and appears to be self-locking. Its construction is shown in detail in Fig. 37.

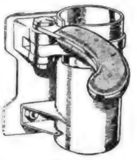


Fig. 37

A rack for Verey lights is mounted on the outside of the nacelle, convenient to the pilot's companion.

Airspeed Indicator—Considerable interest attaches to the fact that this Friedrichshafen bomber is the first enemy machine brought down which has been found provided with an airspeed indicator. This is of the static type, embodying a Pitot head of the usual type. The indicator has a dial of large size, and is altogether a much more bulky instrument than any of a similar purpose used on British machines. An investigation of its mechanism is being made.

Altimeter—This is of the usual type, reading to 8 kilometers.

Level Indicator—This is a somewhat crudely made device, employing two liquid levels. The reading gives the pilot an exaggerated idea of the angle of roll. The glass tubes are sealed up, and contain a dark blue liquid.

Revolution Counters—The dials give readings from 300 to 1,600 r.p.m. The sector between 1,300 and 1,500 is painted black, and these figures are marked with luminous compound, as also is the indicating hand. The manufacturer is Wilhelm Morell, Leipsig.

Air Pressure Gauges—These read from 0 to 0.5 kilograms per square centimeter. There is a red mark against the figure 0.25 kg. The manufacturer is Maximall Apparate Fabrik, Berlin.

Electric Thermometer Dial—This dashboard instrument consists of a box-type meter, the dial reading from 0 to 100° C. The figures 0 and 75 are accentuated by red marks. A switch at the side of the box, having positions marked 1 and 2, allows the temperature of either radiator to be read.

Petrol Level Indicators—These are of the Maximall type, and employ a float immersed in a tubular guide in the tank. This float communicates its motion to a finger working over a circular dial, by means of a thin cord passing over pulleys. These are encased in pipes which are under the same pressure as the tank.

Electric Heating Rheostat—This is marked Aus (off), Schwach (weak), Stark (strong). There are two separate resistance coils, enabling the rheostat also to perform the function of a change over switch.

Wireless—The machine is internally wired for wireless, and the left-hand engine is provided with a pulley and clutch for driving the dynamo. Reference to Fig. 22 will show that this is designed to be mounted on a bracket carried by the outside front engine bearer strut, and that the engine fairing is molded to receive it.

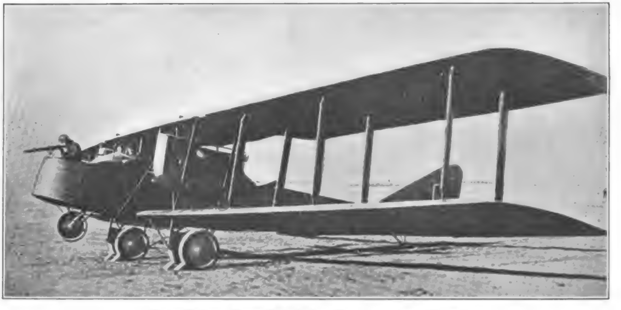
Bombs and Bomb Gear—At each side of the covered-in passage-way in the nacelle are bomb racks, capable of holding five 25-pounder (12 kg.) bombs. Underneath the nacelle are carried two large tubular frames, fitted with cradles of steel cable and furnished with the usual form of trip gear. These racks would, it is believed, be capable of supporting a 300 kg. bomb apiece. The bombs carried, however, evidently vary with the radius of action over which the airplane has to operate.

It is from the inside of the front cockpit that the release of the bombs is conducted. There are seven triggers for the small bomb racks and two levers for the large bomb trips. The cables for this gear are carried under the floor, and are painted different colors for distinction.

Fabric and Dope—Two entirely different kinds of fabric are employed in the Friedrichshafen machine. The wings are covered with a low-grade linen of the class which is employed on most of the enemy machines. It is white in color. Compared with that of British fabrics, the tensile strength is fairly good.

The other fabric, which is applied to the body, tail planes, rudder, elevator, fin and landing gear, is apparently a cheap material much inferior to British fabrics designed for a similar purpose. This body fabric is dyed in a regular pattern of lozenges, the colors being hardly distinguishable from black. The dope is acetate of cellulose.

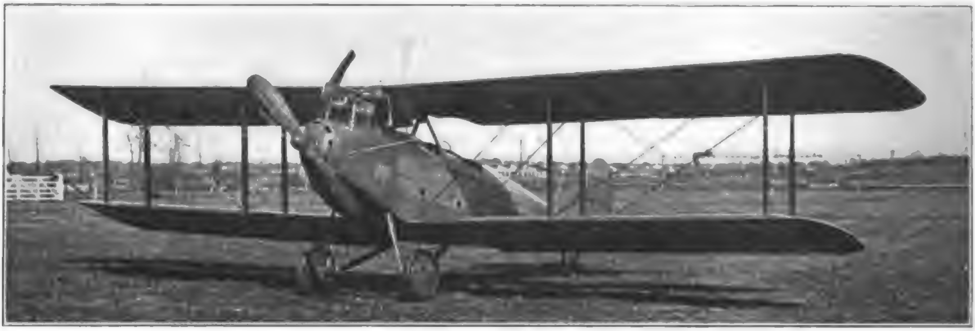
In both cases the dope seems to be carelessly applied.



Three-Quarter Front View of the Friedrichshafen Bomber
Courtesy of the N. Y. World

The Model M.T.2 Lawson Biplane

Consideration was given in this machine mainly to obtain sturdiness, maneuvering ability and vision. It can also be used for primary gun work, since the rear seat is so situated as to allow mounting of guns on the rear pit rim and on top of the cabane. Care was also taken in streamlining all parts possible and this has been accomplished to such an extent that the usual trouble found in removing parts required for inspection is entirely dispensed with.



THREE-QUARTER FRONT VIEW

The characteristics of the M.T.2 are approximately the following:

Span, upper plane	39 ft.
Span, lower plane	36 ft.
Chord	5 ft. 2 in.
Gap	5 ft. 1 in.
Stagger	8 in.
Incidence	3 deg.
Dihedral	1 deg.
Area, upper plane (including ailerons)	200 sq. ft.
Area, lower plane	150 sq. ft.
Length, overall	25 ft.
Height, overall	8 ft.
Weight, empty	1,200 lbs.
Weight, loaded	1,900 lbs.
Speed range	40-90 M.P.H.
Climb in 10 minutes	6,000 ft.
Gliding angle, full load	1 in 9
Engine, Hall-Scott	100 H.P.

Planes

Both wings are in two sections, the top attaching by hinges to hinge plugs secured in the cabane and the lower to plugs secured to fittings and cross tie tubes in the body.

The spars are of I-section spruce and are left solid at both internal and external strut attaching points and also wherever any bolts attach such as for the wing and aileron hinges. The ribs are built of basswood webs, reinforced with fibre strips between lightening holes, and spruce cap strips. Two-ply mahogany veneer forms the nose of the upper surface of both wings while false ribs are placed between the standard ribs from the spruce entering edge to the front spars.

Between spars the ribs are braced by stringers while the bays are separated by square section spruce struts channeled out.

Double wiring takes all drift strains while single wiring is used for truing up.

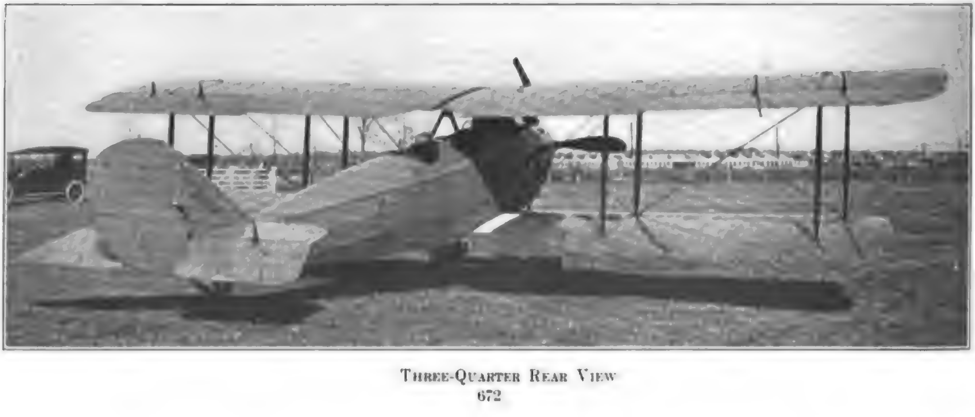
The trailing edge is ash, excepting at the inner ends of the wings and outer ends of the ailerons where flattened steel tubing is used. The outer edges are of steam-bent white ash and slightly curved in plan view to take the tensional pull of the cloth caused through the contraction of the wing dope upon its application.

The lower wing is provided with handholds and running boards alongside the body.

Both wings are connected by two pairs of interplane struts on each side of the body. These are of solid spruce and taper into cup sockets which are fastened to the wing strut plates by a neat bolt and nut. The plates themselves are of the four bolt type whereupon the bolts clamp the spars and are prevented from sliding by blocks attached to the latter.

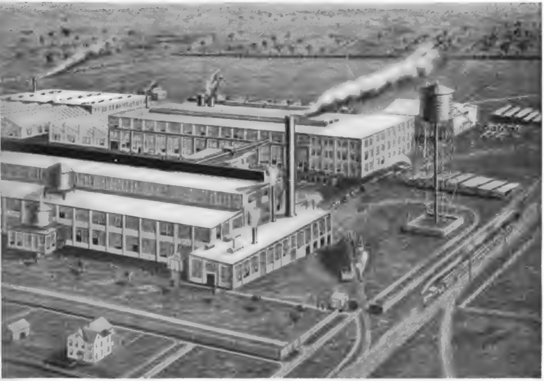
The lift cables are all doubled and are all of ⅛ in. cable with the exception of the main lift and main landing wires, these being 5/32 in.

The ailerons, fitted to the upper wing only, have a total area of 40 sq. ft. and work in conjunction with each other, being interconnected by cable guided through fairleads on top of the upper wing. Each is equipped with two sets of brace arms provided with shackles to take both brace and control cables. The control cables run through pulleys down to the



THREE-QUARTER REAR VIEW

Second Lawson Aircraft Factory, December, 1917



Third Lawson Aircraft Factory, April, 1918

The Lawson Aircraft Corporation

Green Bay, Wisconsin

News of the Fortnight

Ryan Favors Aeronautical Advertising

In view of the misunderstanding regarding the advertising of aeronautical materials and supplies that many manufacturers have labored under, the opinion printed below from John D. Ryan, director of aircraft production, is of special interest. From the reading of this letter, it will appear that no ban is placed on advertising by the fact that a manufacturer is a contractor for the United States Government, or that he is engaged in executing orders for the Air Services. The only restraint is in devulging information that might be of value to the enemy, such as no patriotic manufacturer or publisher would allow to be printed. Mr. Ryan's letter follows:

THE AIRCRAFT BOARD,
WASHINGTON, D. C.,
May 29, 1918.

MR. GEORGE NEWBOLD,
Care AVIATION AND AERONAUTICAL ENGINEERING,
New York City.

DEAR SIR:

I have given some thought to your communication of May 23, 1918, regarding advertising by manufacturers making aeronautical material for the War Department. The purpose of Article XX in the aeronautical contracts, prohibiting the exploitation of the product manufactured, was two-fold, namely—to prevent information of military value from falling into the hands of the enemy and to insure the Government against interruption of production by disaffected persons from a too widely disseminated knowledge of the exact localities where the work was proceeding. At the outset it would seem that both of these considerations were of sufficient importance to warrant the restriction.

As the work progressed some publicity has necessarily been given to the matter. The rule might well be relaxed as to the second consideration noted above; it could hardly be relaxed as to the first consideration. It is not, however, the intention of Article XX to prevent all advertising by contractors. There has been, as far as I am informed, no restriction put upon manufacturers from advertising the fact that they are manufacturers of aircraft material and that they are contractors to the United States Government. In fact, such advertisements appear constantly in aeronautical journals, and, as far as I am advised, without objection from the War Department. It would not be proper for the manufacturer to advertise the quantities or types of articles which he is making for the War Department. If he desires to advertise more than the fact that he is a manufacturer of aircraft and that he is a contractor to the United States Government, then he should submit the material he desires to publish to this office, and I can assure you that such liberality will be had in the rulings as will be consistent with the public safety.

Advertising expense is excluded as an element of cost in cost plus contracts, and I think properly so. For the present, at least, I do not see how the Government can receive any adequate return from the advertising of contractors, and, while that is the case, I do not see how there would be any justification for paying out public moneys to meet the same.

We want the cooperation of the trade journals who are interested in this matter, as we want the cooperation of the American people in the important and difficult task we are attempting to perform.

Articles other than advertising, which you desire published in respect to the development of aircraft designed to aid the accomplishment of this work, will have our earnest and prompt consideration.

Very truly yours,
(Signed) JOHN D. RYAN,
Director of Aircraft Production.

Air Raid Precautions

Following the appearance of enemy submarines on the Atlantic coast steps were promptly taken by the city authorities of New York to anticipate the possibility of air raids by machines possibly carried on board the U-boats.

Police Commissioner Enright after consulting with military and city authorities ordered all display lights, advertising signs or special illuminations throughout the city, including the seashores, discontinued until further orders. This, however, did not include city lights. In official buildings and dwelling houses where lights are used, shades had to be drawn wherever possible to do so.

The order was despatched to all stations and preparations hastily made for its immediate enforcement. The city has now become darker than it was in the fuel saving days.

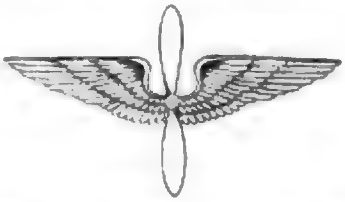
The following statement was also issued by the Police Commissioner:

"The Police Department desires to notify all residents of this city, through the press, that in the event of a raid on this city by enemy airplanes the following signals will be given:

"Siren horns or whistles will be sounded continuously for ten minutes. When this signal is given every one should immediately open the windows of their homes or offices and go at once to the cellar of the premises. After the danger has passed a signal will be given by short blasts of siren horns or whistles at intervals of one minute each for a period of twenty minutes."

New Air Service Insignia

The reorganization of the Army Air Service as a separate branch of the War Department is emphasized by the adoption of new collar ornaments for officers and enlisted men of the Air Service.



The new insignia for officers, which takes the place of the crossed flags of the Signal Corps, is published for the first time in the accompanying cut. The perpendicular propeller measures 1 inch in height, which is the standard height of the collar ornaments of other branches of the Army. The wings measure 1¾ inches from tip to tip. The propeller will appear in silver while the wings are bronze.

A regulation size bronze button showing the same design on its face will be worn by all enlisted men on one side of the collar, while on the other side the bronze U. S. will be worn.

The new hat cord of the air service will be green and black.

Col. R. E. Wyllie of the General Staff of the Army is the officer who selected the new Air Service Ornaments.

Secretary Baker Visits Standard Plant

On June 6 Secretary of War Baker paid his first visit to an airplane factory. Returning from New York to Washington, Secretary Baker decided to see an aircraft factory for the first time. Notwithstanding the fact that he spends millions on aircraft for the Government, he had never seen an aircraft factory.

Mr. Baker visited every part of the plant of the Standard Aircraft Corp., Elizabeth, N. J., including the engineering laboratory and other departments which are guarded with much secrecy.

Some thirty executives of the factory were called by Harry B. Mingle, president of the Standard Aircraft Corporation, to meet the Secretary.

Everybody else in the plant then wanted to see and hear the Secretary, so an outdoor meeting was arranged and messengers summoned the workers. When they assembled Mr. Baker told them something of his experiences at the front.

The Dragon Is Out

The Dragon is the name of a new publication that has been issued by the Fafnir Bearing Co., New Britain, Conn.

To Foster Irish Linen Trade

United States Consul Hunter Sharp at Belfast, Ireland, reports that the Irish Linen Corp., an association "to promote the consideration and discussion of all questions affecting the Irish linen industry" has filed an application for registration as a limited liability, no profit organization.

New Coastal Air Stations

Since the annual Army Appropriation Bill was passed by the House requests for additional appropriations, totalling $164,491,457, have been made by the War Department.

Of the latter amount $16,000,000 is specified for establishing sixteen balloon and seaplane stations, thirteen of which it is proposed to establish on the Atlantic seaboard and three on the Gulf coast.

$100,000,000 Airplane Manufactory

At the request of John D. Ryan, in charge of aircraft production, Senator Chamberlain, Chairman of the Committee on Military Affairs, June 10, introduced a bill for the creation of a $100,000,000 corporation to handle airplane construction.

The intention of the measure is to speed up still further the production of airplanes for the American Army and to put the whole matter on a strictly business basis. Under Senator Chamberlain's bill, the new corporation is to be Government controlled, and is to have the most complete charge of aviation from the production angle.

One of the purposes of the corporation will be to synchronize the activities of aircraft builders here and abroad so that the needs of the American and foreign builders for materials produced or parts fabricated in the United States can be known sufficiently in advance to insure regularity in supply and reasonableness in prices.

The Military Affairs Committee is to consider the measure at once, and is expected to report it without delay so that actual preparations may be started as soon as possible.

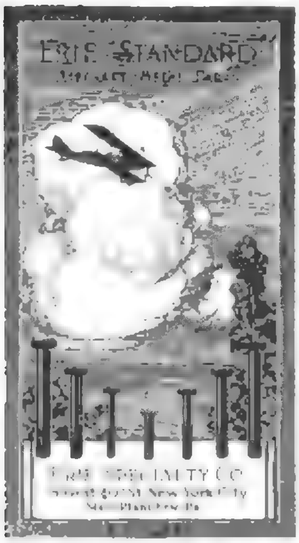
The Air Mail

The Post Office Department issued the following summary of results of the first two weeks of the air mail service:

"With the arrival of the airplane mail in New York on May 28 at 2.30 p. m., the first two weeks' service of the Airplane Mail Service operated by the army for the Post Office Department between Washington, Philadelphia and New York has been completed to the satisfaction of the postal authorities. Out of the twelve trips, eight were completed before 3 o'clock in the afternoon and two before 3.50 p. m. One trip was completed at 2.25 p. m. and two at 2.34 p. m. There were two delays when the mail reached New York at 4.45 p. m. The airplane mail from the North arrived in Washington six times before 3.30 p. m.; twice between 3.30 and 4.00 p. m., and four times after 4.00 p. m.

The Post Office Department is considering the extension of the system to Boston. It will be about two months before regular trips will be made.

The First Aircraft Parts Catalog



The first catalog devoted exclusively to metal parts for aircraft has been issued by the Erie Specialty Co., 8 West 40th St., New York City, whose main plant is at Erie, Pa. This catalog, which is attractively gotten up, consists of 24 pages of heavy coated paper and a four-page cover, the front of which is printed in blue and black on gray stock and shown in the accompanying engraving. This booklet measures 5¾ inches wide by 10 inches high.

The inside title page consists of a reproduction from an artistic pen-and-ink drawing, while on the other pages are told the aims of the company "to produce 100 per cent quality," together with details of sizes of hexagon head bolts, ball hexagonal nuts, hexagonal castellated ball nuts, hexagonal castellated nuts and flat head clevis pins. In addition there is supplied a telegraph code for standard Erie parts and a page is devoted to the subject of Erie cooperation. This catalog should be a useful reference book for all aeronautical engineers and mechanics.

S. A. E. Meeting at Dayton

After the demonstration of the Liberty Engine, for which permission has just been granted by Washington, one of the features of the Convention of the Society of Automotive Engineers, held in Dayton, Ohio, June 16, 17 and 18, is the special dinner given in honor of Orville Wright, who, with his brother Wilbur, was the first man to perfect a successful heavier-than-air machine.

In view of the importance of aircraft in the present world war, the tribute is particularly fitting at this time to the Wright Brothers, in Dayton, Ohio—their home, and where all of their experimenting was done. This year the S. A. E. Convention is devoted strictly to the war, and to the machines and other devices that are making it possible for us to win.

A number of unique features are provided by the Convention Committee, for the entertainment as well as enlightenment of the visitors in various win-the-war devices.

The reservations for the Orville Wright dinner have been limited to 1200. President C. F. Kettering will act as toastmaster and the Governor of Ohio, James M. Cox, will be one of the principal speakers at the banquet.

The meetings are held at Triangle Park in the open air; and the published program follows:

Program

SATURDAY, JUNE 15

10.00 A.M. Meeting of eight divisions of Standards Committee at Dayton Engineers Club.

SUNDAY, JUNE 16

10.00 A.M. Meeting Standards Committee, Dayton Engineers Club.
1.00 P.M. Meeting S. A. E. Council, Dayton Engineers Club.
8.00 P.M. Section Conference, Dayton Engineers Club.

MONDAY, JUNE 17

9.00 A.M.—Registration and badges, entrance Triangle Park.
9.30 A.M.—Exhibits in meetings pavilion.
  a. Airplane engines.
  b. Airplane wings and parts.
  c. Liberty engine and parts.
10.00 A.M.—Business session. Meetings pavilion.
  a. President's remarks.
  b. Treasurer's report.
  c. Membership Committee's report.
  d. Section Committee.
  e. Publication Committee.
  f. Election Nomination Committee.
  g. Constitution amendments.
  h. New business.
  i. Standards Committee's report.
12.30 noon.—Luncheon, dining hall at Triangle Park.
1.15 P.M. Machine firing through propeller.
1.30 P.M. Petroleum refining, paper and demonstration. C. W. Stratford.
3.00 P.M.—Heavy oil engines for automotive purposes.
  a. S. E. Sargent.
  b. P. L. Scott.
4.00 P.M.—Airplane demonstrations over park.
  a. Airplane raid on trenches.
  b. Formation flying.
  c. Stunt flying.
  d. Maneuvers.
  e. Bombing.
Opportunity for examining engine and plane exhibits in meetings pavilion
7.00 P.M.—Orville Wright dinner, dining hall in Triangle Park.
10.00 P.M.—Movies in front of baseball stand, Triangle Park. Illuminations.

TUESDAY, JUNE 18

9.00 A.M. Meetings pavilion open for examination of airplane engines, planes and Liberty engine exhibits.
9.30 A.M.—Demonstration manufacturing machine in Triangle Park.
10.00 A.M.—Address, Propeller Design, F. W. Caldwell.
10.20 A.M.—Address, Present Day Problems in Aeronautics, W. B. Stout.
10.50 A.M.—Address, Airplanes of Today, F. L. Faurote.
11.20 A.M. Address, Comparison of Aviation Engines, Mr. Lewis.
11.45 A.M.—Possible report on Liberty engine tests.
12.30 noon—Luncheon, dining hall Triangle Park.
1.30 P.M.—Reports on international aircraft conference.
  a. C. M. Manly.
  b. D. H. Ehrman
  c. C. F. Clarkson.
2.15 P.M.—Symposium on tractor development.
  a. C. M. Eason.
  b. D. F. Davies
  c. R. O. Hendrickson.
  d. Dent Parrett
3.30 P.M.—Standardization in transport vehicles.
  a. Captain Crossby, England.
  b. Captain Vandevelde, France.
4.00 P.M.—Demonstrations and exhibits.
  a. Farm tractors
  b. Ordnance vehicles.
  c. Quarter vehicles
  d. Medical corps vehicles
  e. Miscellaneous.

WEDNESDAY, JUNE 19

Dayton Factory Visits. Those members desiring to visit Dayton factories will do so on this date. It will be necessary to signify Monday or Tuesday what factories you desire to visit and to fill out application cards at information bureau, Triangle Park or Miami Hotel.

A full report of the meeting will be printed in the next issue of AVIATION AND AERONAUTICAL ENGINEERING.

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Orville Wright (Left) in Front of a Liberty D.H.-4

VOLUME IV
Number 11

Two
Dollars
a Year

SPECIAL FEATURES
THE S. A. E. AERONAUTICAL MEETING
TECHNICAL PAPERS ON AERONAUTICS
THE ORVILLE WRIGHT DINNER
PRODUCTION OF AMERICAN AIRCRAFT
CONSTRUCTIVE SUGGESTIONS FROM MANUFACTURERS
THE NEW HALL-SCOTT SIX CYLINDER ENGINE

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BY
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120 W. 32nd ST. NEW YORK

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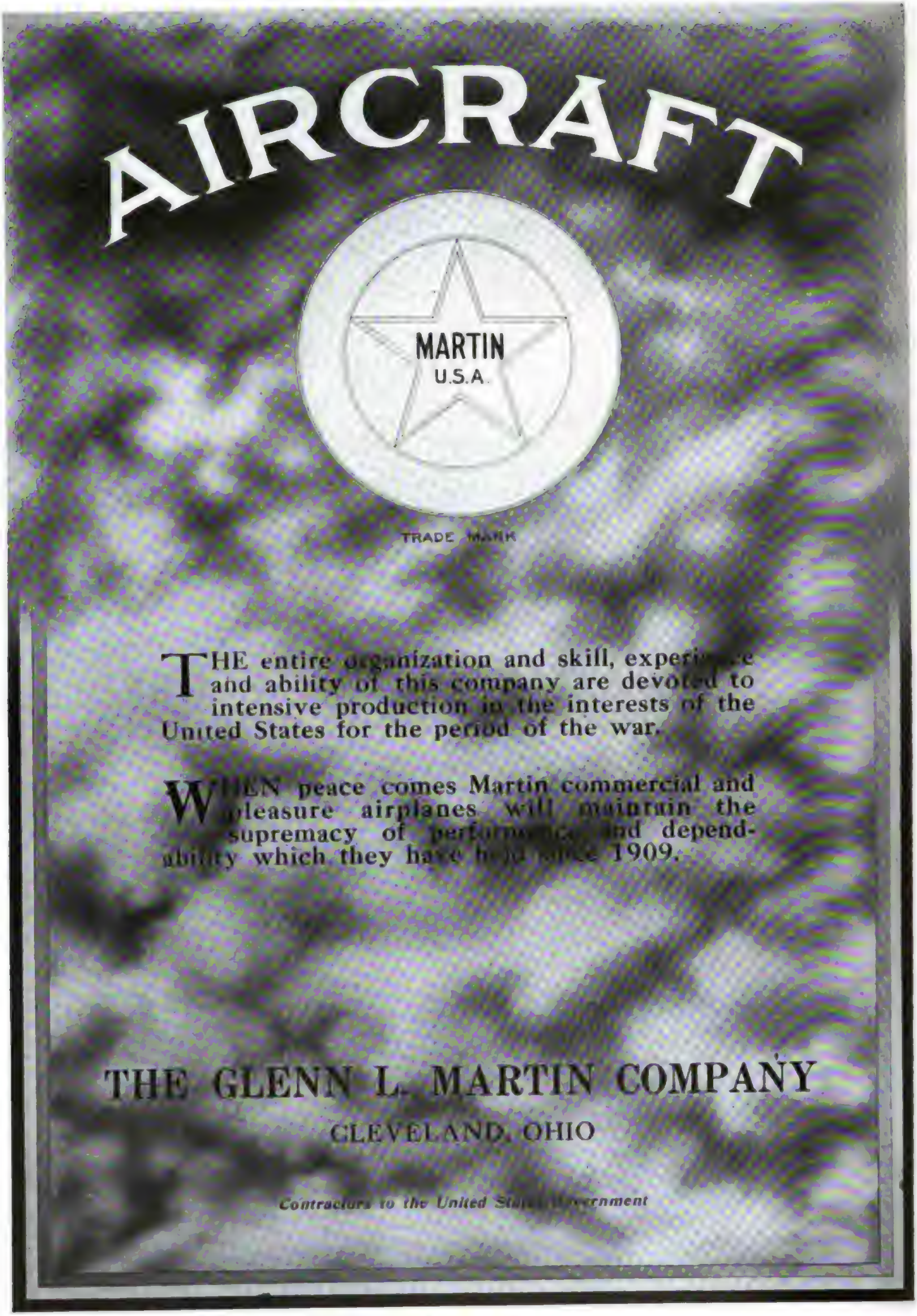

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CLEVELAND, OHIO

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JULY 1, 1918

AVIATION
AND
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VOL. IV. NO 11

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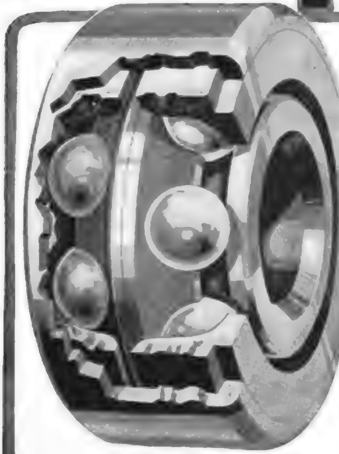

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BUSINESS MANAGER

Vol. IV July 1, 1918 No. 11

The S. A. E. Aeronautical Convention

The annual mid-summer convention of the Society of Automotive Engineers, which was held at Dayton, Ohio, from June 15 to 18 inclusive, was one of the most notable gatherings in the history of the American aircraft industry. Some 1200 members of the Society attended the convention, which by the nature of its working program and exhibits of automotive apparatus as well as a large attendance of aircraft constructors and aeronautical engineers from the Army, the Navy and the Trade could truly be classed as a representative aeronautical meeting.

Orville Wright at the Wheel of a Modernized 1912 Type Wright Biplane

Interesting Exhibits

A large hall at Triangle Park was entirely devoted to an exhibition of airplanes, aero-engines, parts, and aerial armament, among which the following were particularly worthy of note: a DeHaviland-4 complete with military load and Liberty-12 engine; a DeHaviland-4 body with engine, showing construction; separate DeHaviland wing and control assemblies, showing construction; a Spad single-seater pursuit biplane with Hispano-Suiza engine; a two-seater German Rumpler biplane fitted with a 225 hp. Benz engine, bombs and two machine guns and a first model Wright machine with its 12 hp. engine.

The following engines were also exhibited: a Liberty-12 dissembled and one assembled weighing 830 lb. and credited with 400 hp. at 1700 revolutions; a 360 hp. Rolls-Royce weighing 900 lb. and rated at 1800 r.p.m.; a Renault-12 developing 280 hp. at 1500 r.p.m. and weighing 805 lb.; an eight-cylinder Hispano-Suiza engine weighing 525 lb. and rated 200 hp. at 2000 r.p.m.; the same engine of the geared down type producing the same horsepower and engine speed and weighing ten pounds less; a nine-cylinder LeRhone weighing 294 lb. and rated 180 hp. at 1200 r.p.m.; a Mercedes six-cylinder vertical of 150 hp. at 1250 r.p.m. weighing 825 lb.; a vertical six-cylinder Benz engine weighing 785 lb. and rated at 225 hp. at 1400 r.p.m.

During the meeting, three DeHavilands gave interesting exhibitions in stunt flying and executed every conceivable evolution.

Following is a brief summary of the program of the convention:

Saturday and Sunday were mainly spent in meetings of the Standards Committee, the S. A. E. Council and a Section Conference.

Monday the exhibit of airplanes, aero-engines and parts was opened and demonstrations were given of synchronized machine guns firing through air screws, airplane raids on trenches, formation flying, stunting, maneuvers and bombing. Five large and fifteen small planes were instrumental in this demonstration and some very fine flying was performed by Aviators Rinehart, Lewis, Doolittle and Freeman, of McCook Field. Papers were read the same day by C. W. Stratton on Petroleum Refining, and by S. E. Sargent and P. L. Scott on Heavy Oil Engines for Automotive Purposes. In the evening a banquet was given in honor of Orville Wright.

On Tuesday further demonstrations of airplanes took place, and papers were read by F. W. Caldwell on Propeller Design; by W. B. Stout on Present-Day Problems in Aeronautics; by F. L. Faurote on Airplanes of Today, and by Mr. Lewis on Comparison of Aviation Engines. Reports were rendered by C. M. Manly, D. H. Ehrman and C. F. Clarkson on the International Aircraft Conference; by C. M. Eason, D. F. Davies, R. O. Henderson, Dent Parrett and others on Tractor Development; by Captain Crossley (England) and Captain Vandevelde (France), on Standardization of Transport Vehicles.

On Wednesday, the last day of the meeting, the members visited several Dayton factories.

Exhaust Headers and Mufflers for Airplane Engines*

By Archibald Black

Chief Engineer, L.W.F. Engineering Co.

In the following notes no attempt has been made to treat exhaustively the design of exhaust headers or mufflers for airplane engines. The paper is intended chiefly to record some data collected on this subject during the past several years.

The exhaust header's primary purpose is to carry exhaust gases away from the engine, but it may be designed to perform certain other functions to advantage. The most important of these is probably the muffling of the sound of the exhaust, which may be brought about by a properly designed header.

In present practice the exhaust is taken care of in several radically different ways, the devices of the different designers ranging from the open port to the elaborate combined header and muffler as now used on some machines.

Typical Constructions

Fig. 1 shows the open port, which was very popular on the old engines and was used until recently on the Curtiss 90-hp. JN-4 type engine. In that type no effort was made to carry away the gases or to muffle the noise. Fig. 2 shows the "stub tube" method, used on some Hall-Scott installations and recommended by the Hall-Scott Company for its engines. In this system each cylinder is furnished with an individual exhaust pipe several inches long, which points straight out from the engine and is cut off on the outer end at an angle of about 45 deg. to prevent the air from causing a back pressure when the airplane is moving. While this arrangement assists the cooling of the engine, it gives the maximum of noise and would appear therefore not entirely satisfactory for either military or sporting machines.

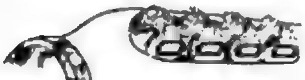

FIG. 1

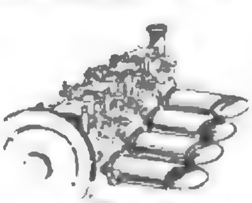

FIG. 2

Fig. 3 illustrates what has come to be known by many as the German system on account of its origin on machines of that nation and apparent popularity among German designers. Tubes extend upward from each cylinder into the common header, which is of stream-line section and points upward and slightly to the rear, directing the gases over the top of the upper wing. This reduces the noise heard from below and appears to be a very practicable, although not final, solution of the problem.

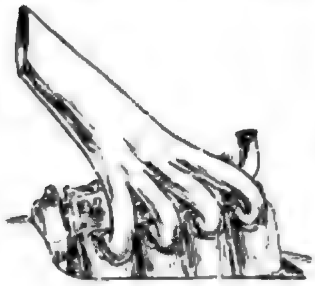

FIG. 3

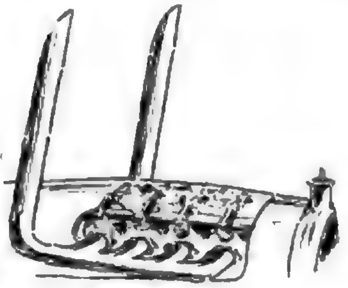

FIG. 4

Fig. 4 shows an adaptation of the German system used on recent Curtiss JN-4 machines.

Fig. 5 is the original L-W-F header consisting of short tubes run at right angles into a manifold tube, the front end being closed and the rear end connected by a flexible metallic tube to a straight pipe leading along the body to the rear of the pilot, the end being open to permit the escape of the gases. This design was discarded, after the first few machines, in favor of the method illustrated in Fig. 6. Here the individual pipes sweep backward on a liberal radius into the manifold, and the flexible pipe is replaced by a smooth steel tube, which is perfectly straight on some models, depending upon the engine used.

Fig. 7 show the new header and muffler as fitted to some of the Curtiss machines. This header connects to a tube, which extends backward along the body and terminates in a muffler.

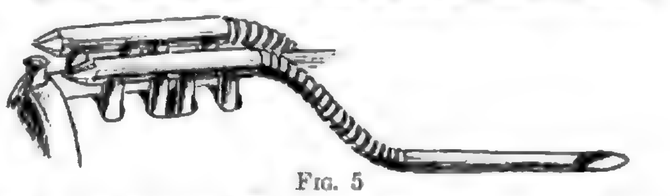

FIG. 5

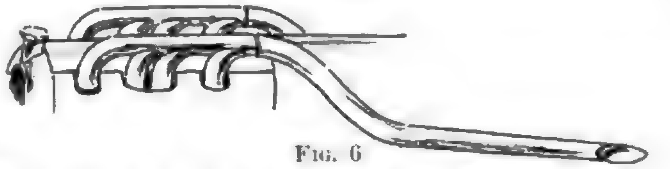

FIG. 6

The muffler is simple and most ingeniously designed; the exhaust tube is slotted and the metal bent outward to form two parallel flanges separated by spacers. The author at the time had no opportunity to examine the earlier of these mufflers as installed on R-4 machines, but the following description was reported to him by the field department of the L.W.F. Company. The slot was about 5 to 6 ft. long and about ⅛ in. wide, starting near the engine and running back to the end of the tube, which tapered from the full section of the engine to a comparatively small section, open to the atmosphere, at the rear.

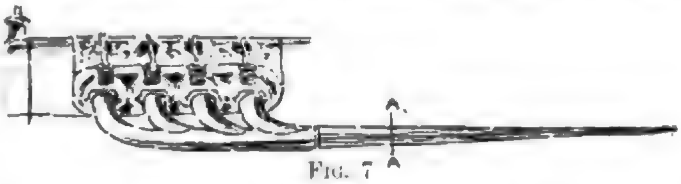

FIG. 7

One of the Curtiss engineers stated that no material loss of power was found to be caused by the use of this muffler. It has been generally conceded by those who have heard the engine running with the muffler in place that the noise of the exhaust is reduced to much less than its former volume. This bears out the author's experience with similar devices installed on several engines; these are referred to later in this paper.

At a later date the author made an examination of a similar muffler installed on one of the Curtiss Company's JN machines equipped with Hispano-Suiza engines. This muffler had no large opening in the rear, the slot extending around the end instead. The slot was about 4 ft. long and ⅛ in. wide, approximating an allowance of about 0.04 sq. in. of slot per b.hp.—an extremely small area.

Fig. 8 shows a method of muffling the exhaust gases devised by Deperdussin, the French constructor. This is shown as applied to an engine of the rotary type, the gases being carried through internal ducts to outlet holes at the rear of the body.

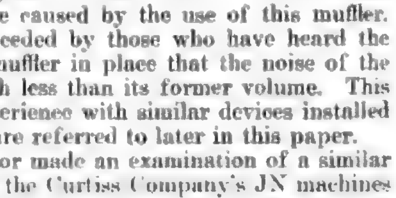

FIG. 8

The French Spad, Fig 9, is furnished with exhaust headers extending backward for about 6 ft. from the engine. These headers are 3 in. inside diameter and terminate in a muffler consisting of a tube, round at the end, fastened to the exhaust header, which is flattened toward the rear, where it ends up about ½ in. in height and is considerably wider than the diameter of the front end. This rear end is closed except for four slots similar to those in top and bottom, described below.

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* Paper read before the S. A. E. Convention.

In the flattened part, both on top and bottom side, are a number of slots 1 in. long and ⅛ in. wide, with round ends. Each muffler has 78 such slots, giving a total area of 0.1267 sq. in. per brake horsepower for two such mufflers, based on 150 b.hp. (the rating of the Hispano-Suiza).

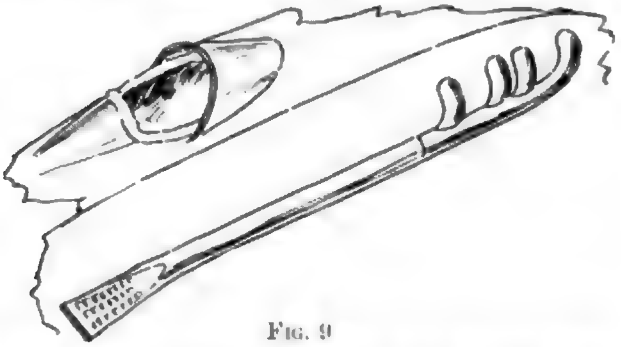
FIG. 9

The exhaust pipe allows 0.08836 sq. in. cross-section per b.hp. and has considerable capacity due to its length. This capacity, by allowing expansion of gases, should assist the action of the muffler considerably. The above figures are exact measurements.

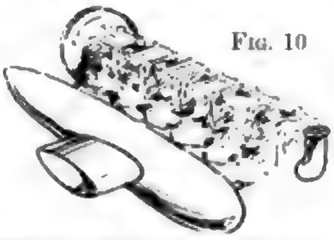
FIG. 10

Fig. 10 shows the manifold used on later Mercedes engines. No detailed information on the construction of this manifold has been obtained by the author.

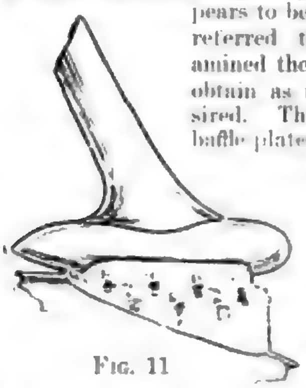
FIG. 11

Fig. 11 illustrates a manifold used on Farman and Breguet machines which appears to be similar in design to the Mercedes referred to above. The author has examined the Breguet manifold, but could not obtain as much detailed information as desired. The inside apparently contains no baffle plates and the pipes from the cylinders enter tangentially to the body. This construction is evidently designed to reduce the velocity of the gases by causing them to expend their energy in eddy currents in the main chamber.

Fig. 12 is a scale drawing of one of the mufflers tested under direction of Prof. W. T. Fishleigh at the University of Michigan a few years ago. Five mufflers of different designs were experimented with and detail reports were published in *Horseless Age*, May, 1915, issue. Of those tested, the muffler shown here was rated as the best in muffling ability and low back pressure, and one of the two best in low horsepower losses. This muffler was also the lightest of the five. Although the most efficient of those tested, it showed a b.hp. loss of 3.6 per cent with engine delivering 38 b.hp. This device weighed 14.5 lb. and had a capacity of 847 cubic inches.

Fig. 13 is a scale drawing of one of the mufflers tested under the direction of Profs. H. Diederichs and G. B. Upton of Cornell University. Details of the tests are given in the Second Annual Report of the United States Advisory Committee for Aeronautics. The results of tests of the particular muffler shown are given in part in Table I. It will be noted that this muffler caused a loss in horsepower of only 1.5 per cent, from which it would appear that it is efficient enough to justify its application in many cases to airplane engines.

Another type of muffler has been experimented with recently by J. L. Cato of the L-W-F Company. This muffler was somewhat similar to the Spad device, but it had a slot in the end instead of being closed and was provided with small semicircular louvers in the side instead of slots. The areas allowed and the results obtained were in general very similar to those of the Spad muffler.

Notes on Manifold Design

The two main considerations in the design of exhaust headers and mufflers are the elimination of back pressure and the reduction of noise, which two requirements are, unfortunately, generally incompatible in practice. It is a simple matter to design headers fulfilling one, but not both conditions. The combining of both calls for a careful study and proportioning of even the smallest features of the device.

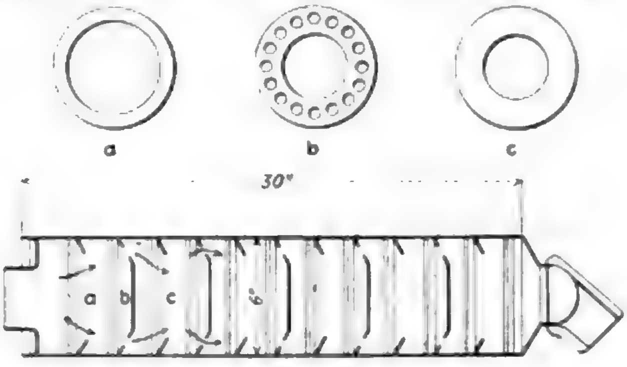

FIG. 12

Research work of the manufacturers of blowers and air-moving machinery is of considerable help in this work. F. L. Busey conducted a series of experiments * to determine the effects of bends in air ducts. The curves published by him, combined here in Fig. 14, show that, when the radii are small, bends in square pipe offer more resistance than bends of the

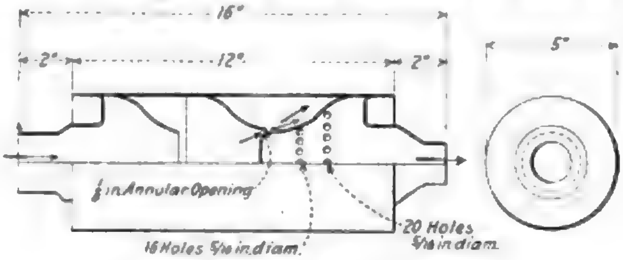

FIG. 13

TABLE I—TESTS ON MUFFLER ILLUSTRATED IN FIG. 13

BRAKE HORSEPOWER		Horsepower Loss, per Cent	BRAKE MEAN EFFECTIVE PRESSURE LB. PER SQ. IN.		Brake Mean Effective Pressure, Loss, Lb. per Sq. In.	Speed Drop, per Cent
Without Muffler	With Muffler		Without Muffler	With Muffler		
69.8	68.6	1.5	87.7	86.8	0.9	0.52

TABLE II—DIAMETER OF EXHAUST PIPES FOR 30 TO 300 B. HP.

Based on area of 0.07 sq. in. per b.hp.

Brake Horsepower	Area Required, Sq. In.	DIAMETER TO NEAREST 1/16 IN. WITH NO. 20 U. S. GAGE WALL		Brake Horsepower	Area Required, Sq. In.	DIAMETER TO NEAREST 1/16 IN. WITH NO. 20 U. S. GAGE WALL	
		Inside	Outside			Inside	Outside
30	2.1	1 5/8	1 11/16	170	11.9	3 7/8	3 15/16
40	2.8	1 7/8	1 15/16	180	12.6	4	4 1/16
50	3.5	2 1/8	2 3/16	190	13.3	4 1/8	4 3/16
60	4.2	2 5/16	2 3/8	200	14.0	4 1/4	4 5/16
70	4.9	2 1/2	2 9/16	210	14.7	4 5/16	4 3/8
80	5.6	2 11/16	2 3/4	220	15.4	4 7/16	4 1/2
90	6.3	2 13/16	2 7/8	230	16.1	4 1/2	4 9/16
100	7.0	3	3 1/16	240	16.8	4 5/8	4 11/16
110	7.7	3 1/8	3 3/16	250	17.5	4 3/4	4 13/16
120	8.4	3 1/4	3 5/16	260	18.2	4 13/16	4 7/8
130	9.1	3 3/8	3 7/16	270	18.9	4 15/16	5
140	9.8	3 9/16	3 5/8	280	19.6	5	5 1/16
150	10.5	3 11/16	3 3/4	290	20.3	5 1/16	5 1/8
160	11.2	3 3/4	3 13/16	300	21.0	5 3/16	5 1/4

NOTE.—While the allowances given are liberal and based on experience, this table should not be considered final. Additional experiments to determine effects of changing area are always desirable.

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* Loss of Pressure Due to Elbows in the Transmission of Air Through Pipes or Ducts. Trans. American Society Heating and Ventilating Engineers, 1913.

same radius in round pipe. The reverse is the case when radii are large. This change of condition takes place when the radii equal about 0.6 times the diameter or side.

The American Blower Company also has made some tests and publishes among its data sheets one giving the resistance of bends in terms of equivalent length of straight pipe.

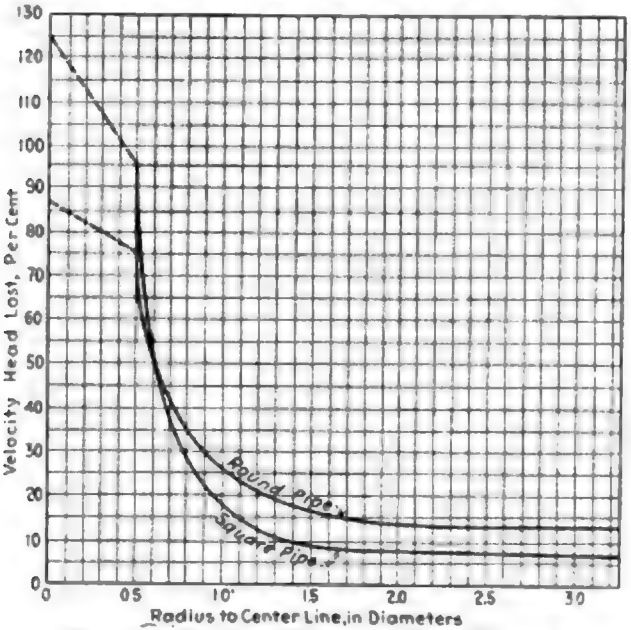

FIG. 14. PRESSURE LOSSES IN PIPE ELBOWS

It will be noted from Fig. 14 that the resistance of the bend is lowest when the radius is equal to 2½ times the diameter; that nothing is gained by making it greater than this; and that this resistance rises to a prohibitive value if the radius is less than 1 to 1½ times the diameter of the pipe. While this curve is based on tests which were made at lower speeds than are probably encountered in an exhaust manifold, Willis H. Carrier[*] concluded, from results of experiments, that losses in elbows through which air is flowing depend on the radius of curvature of the elbow and not on its size or on the velocity of the air.

It would therefore appear safe to assume that the curve given applies equally to the high velocity of flow in an exhaust manifold. Bends of high resistance in manifolds, if near the engine, will sometimes show up by becoming red hot. Sudden changes in the area of the exhaust pipe should be avoided. The areas of the individual exhaust pipes are usually fixed by the necessity of making their ends conform to the ports in the cylinders in order to obtain this condition. When this is not the governing condition, personal experience with different installations of headers and some investigation of the areas of exhaust ports on several successful aircraft engines suggests that 0.14 to 0.16 sq. in. of area per b.hp. of cylinder is a liberal allowance. The exhaust ports of the Hall-Scott A-5-A, Thomas 8, Sturtevant 5A and Liberty, some of the engines studied, averaged 0.1668 sq. in. per b.hp. As large a radius as possible should be used in these tubes which enter the manifold. The latter should be of large sectional area at the outlet end, tapering down to equal the area of the individual pipe at the other end. Where a tube extension is used it should be as straight as possible and of the same sectional area as the manifold end.

The proper area for the large end of the manifold is best determined by experiment with several different sizes, noting the effect upon the horsepower of the engine while running on the dynamometer. This best size will probably vary with different engines, being governed, no doubt, by piston speed and the shape of exhaust ports, as well as by the brake horsepower of the engine. As these experiments, however, cannot always be made, the author recommends allowing about 0.07 sq. in. of area per b.hp., which figure is the average of the several American and foreign installations. When two headers are used, as on eight or twelve-cylinder engines, it should be kept in mind that each header handles only half of the total exhaust. For most engines this allowance will be found to be liberal.

Exhaust headers have been developed, by experiment, which have had areas as low as 0.045 sq. in. per b.hp., but it would not seem advisable in the absence of a series of experiments to attempt to reduce the figure given.

In cases where headers are inclined to overheat, it has been suggested that they be furnished with a series of longitudinal fins, welded to the tube, to increase the radiation. Automobile engines have been built which were equipped with headers having fins somewhat similar to these.

Table II gives the required outside diameter of No. 20 U. S. gage tube for various horsepowers, based upon the figure recommended above. This table, while giving staisfactory results, should not be considered final. It would be advisable to remove the manifold and note if there is any change in maximum speed of engine when running without it before the question is considered settled for the particular design.

Notes on Muffler Design

A very interesting and instructive treatise on the principles underlying the design of mufflers is found in part of the previously mentioned report of Profs. H. Diederichs and G. B. Upton.

Another interesting report of experiments, previously referred to, published in *Horseless Age*, contains conclusions from results and discussion of the principles of design.

The chief principle to be kept in mind in designing exhaust mufflers is the slowing down of the exhaust gases until their speed is below that of sound. This is accomplished by regular expansion, surface friction and the changing of the direction of flow. Most mufflers embody all three principles in greater or less degree.

It would appear to be a reasonably safe assumption that mufflers of the type shown in Fig. 13 may be designed for engines of any horsepower by making the areas of pipes and volumes of chambers proportional to the horsepower. The muffler shown is drawn to scale and was tested on an engine of 60 to 70 brake horsepower.

The Curtiss type muffler seems to be one of the simplest and most effective devices in use, and some experiences of the author and his associates with mufflers of this type may be of interest. Experimental mufflers were designed along these lines and were tested on engines of different makes. The noise of the exhaust was, in each case, reduced to very little more than the noise of an automobile truck engine of large power. Tests made with and without the muffler in place showed that no difference in the number of revolutions per minute of engine could be detected with the tachometer while the engine was running at full speed. With the engine running at full speed, one's hand could be held against the muffler slot without discomfort, in contrast to which it was noticeable that the heat of the gases became uncomfortably great when one's hand was held a couple of feet away from the end of the exhaust pipe without the muffler. The speed of the gases was reduced to a slight puff.

Other work prevented the carrying on of further experiments, but the results appeared to suggest that the mufflers which were from four to five feet long could have been reduced in length without loss in speed of engine or muffling effects.

While these mufflers were in use, several things were noted which called for attention. One engine was of the geared-down type, and when the muffler was in place the sound of the gears appeared to be of considerable volume, this noise being plainly heard above the sound of the exhaust. As these gears were lubricated by the engine oiling system, it would appear that some reduction of this noise could be obtained were the engine designed to permit lubricating them with a light grease instead of oil. It was also noted, with most of the engines, that once the exhaust was muffled, several other noises became apparent. These included the rattle of valve mechanism and noise of the propeller. In flight, while gliding with the engine running slowly, the "singing" of the wires was naturally more noticeable than before. The engines used in the above tests included a Sturtevant 140 b.hp. Hall-Scott Model A-5-A, Liberty 8 and Liberty 12.

No high degree of accuracy is claimed for the tests described, as they were field and not laboratory tests. The results indicated, however, that in design of mufflers of this type it is advisable that the slot be kept narrow ($\frac{1}{16}$ in. was found to be satisfactory), and that a net area of 0.05 to 0.06 sq. in. per b.hp. is ample. It did not appear to be necessary to leave any opening at the rear end as was done in the Curtiss

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[*] Fan Engineering, 1914 Edition, page 114.

R-4 muffler, better results in muffling having been obtained with the smallest end. It is interesting to note that the mufflers now used on the Curtiss JN Hispano-Suiza model have only a small opening in the end.

Materials of Construction

The materials of construction naturally depend upon the type of machine and its size, but for all ordinary work the use of No. 20 U. S. gage for headers and No. 22 U. S. gage for pipes and mufflers will insure parts which will hold up well. For machines of which extreme climbing ability and consequent low weight are demanded, these could be reduced to paper thickness, but it would probably be necessary to renew them often.

Although contrary to general opinion, the author has been informed, on good authority, of cases in which the horsepower of an engine with open exhausts has been *increased* by fitting it with a well-designed manifold. This was found in some cases by dynamometer tests and in others by noting the r.p.m. for the two conditions. This effect is, no doubt, due to the gases moving at such high speed that suction is set up in the header, thus giving the effect of exhausting into partial vacuum.

References

(a) Report No. 10 in Reports of U. S. Advisory Committee for Aeronautics 1916-17.

(b) Data sheets issued by the American Blower Company.

(c) U. S. Patent No. 1,106,193 to Deperdussin.

(d) Automobile Muffler Losses Experimentally Determined, *Horseless Age*, May, 1916.

(e) Heat-balance Tests of Automobile Engines, by Prof. W. T. Fishleigh and W. E. Lay, *Transactions S. A. E.*, Part I, page 82.

(f) *Fan Engineering* (1914 Edition), by Willis H. Carrier.

(g) Loss of Pressure Due to Elbows in Transmission of Air Through Pipes and Ducts, by F. L. Busey, *Trans. Amer. Soc. of Heating and Ventil. Engrs.*, 1913.

(h) Flow of Air in Heating and Ventilating Ducts, by L. A. Harding, *Trans. American Society Heating and Ventilating Engineers*, 1913.

(i) Coefficient of Friction of Air Flowing in Round Galvanised Air Ducts, by Prof. J. E. Emswiler, *Trans. American Society Heating and Ventilating Engineers*, 1916.

Present Day Problems in Aeronautics[*]

By Wm. B. Stout

Technical Advisor, Aircraft Board

Airplanes as at present constructed can never become an industrial proposition nor be feasible for commercial work. A radical change in airplane design, if not in theory, will be necessary before air travel, aside from war conditions, can be a commercial success.

WM. B. STOUT

This radical change probably will be the result of rational development, step by step, rather than of any sudden revolution in design.

As related to war conditions—the only angle of approach in which we are now interested—these statements are of equal import; for cost, either of the machine or of its operation after purchase, is but an expression of man-hours—the most valuable and important item to be conserved during the war period.

The purpose of this paper is to discuss (a) present-day aircraft problems which have bearing in creating the new types of aircraft that must come; and (b) the methods of operation and commercialism that will be necessary in connection with the new types.

After two years experience in war, aircraft have become a deciding factor in combat, and it is becoming more probable every day that the present war will be lost or won in the air.

To win the war in the air there must be sufficient dominance in numbers of planes to over-ride enemy territory and demoralize his fighting units, either by direct offensive or by destruction and stoppage of supplies and transportation.

Europe can hardly produce under present conditions a sufficient number of planes to entirely meet the situation.

The solution is *America's problem*.

Every engineering problem at its inception presents certain disadvantages and certain advantages. The engineering result or design must of necessity be a compromise to meet the conditions.

No matter what the final design, it will have certain liabilities as well as assets. He is the best engineer who can design the machine, which, as a result of compromise, has the largest percentage of assets with the smallest percentage of liabilities.

Before analyzing the problems and the possible solutions, it is necessary to look at the disadvantages under which America must work as compared with the Allies abroad, so that our final design may best meet all commercial and shipping requirements as well as those of production and technical performance.

In other words, we must first analyze "what to do" before we can determine "how to do it."

In analyzing what to do we must remember that the technical performance of the plane itself is not necessarily the vital factor, but that production capability and strategical performance may in many cases outweigh technical possibilities. It were better, for example, to build planes of 75 per cent performance, and ship them abroad, than to spend time attempting to build 100 per cent planes that we can never hope to build. By all odds, whatever we do, let us *build something;* this has been the spirit with which the American problem has been approached.

In this war it has been possible in some cases to turn engineering disadvantage to strategic advantage. An illustration is the Albatros and other types of planes that Germany has developed.

When the war broke out, the 100 hp. Mercedes engine was practically standardized for German aircraft—and the Hun has constantly adhered to three or four types of engines that he might have quantity even at the expense of quality.

The Mercedes engine as produced was of heavy weight, in comparison with what the Allies were producing shortly after the war was started. It was reliable, however, and the keenly analytical German engineers, being willing to bear with this disadvantage, designed a ship to fit the engine. It was known that the speed of this plane would not be so great as that of the British and French constructions, or would it climb so quickly; it must be able, however, to fight with a chance of success, the swifter, quicker-climbing Allied aircraft.

Time was, therefore, spent by Germany in constructing in the Albatros, a plane that can rise to a tremendous ceiling and, once it attains this altitude behind its own lines, cruise out and over beyond the firing line, but within diving distance of home, waiting for the enemy to appear. This machine was so heavy and so well stream-lined, that it could lose altitude very rapidly. If an allied plane was unfortunate enough to find itself beneath an Albatros there was small chance of safety in making for home, for the Albatros could dive onto the Allied plane much faster than the latter could dive away even with its engine to assist, so that although technically an inferior plane, strategically the Albatros was for a considerable period no mean antagonist.

Nor was this the only strategy in the Albatros design. The body was built up of thin wood sections nailed together on laminated wood bulkheads—a sort of compromise between boat construction and that of the usual airplane body. The struts between the wings were of steel tubing, the spars of box sections made of small pieces laminated together.

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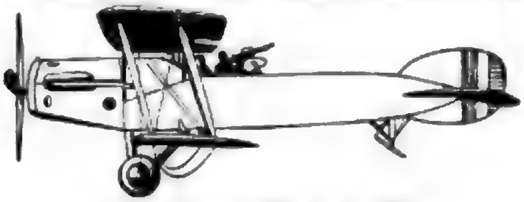
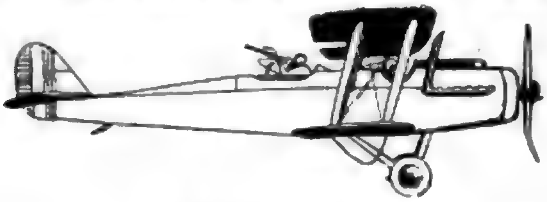
[*] Paper read before the S. A. E. Convention.

The whole design, while wonderfully trim and, made, one might say, from "cigar boxes and broom-sticks," was as nearly a production job as had yet been devised in wood. With this plane Germany had began in the air and has kept strategy and tactics a major part of design ever since. This example shows the thoroughness with which the Germans have taken the disadvantages which they had had to overcome and have made them an advantage by the way in which they have applied the design.


The Bristol Fighter, 1917

America, like Germany, has certain definite and deciding disadvantages that must be overcome in its aerial war program—but disadvantages by the application of American ingenuity may even turn to eventual advantage. These disadvantages may be listed as follows:


The De Haviland 4, 1917

(1) Lack of airplane manufacturing experience.

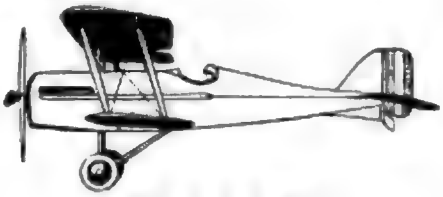
(2) Distance from center of operation.

(3) Lack of knowledge of production methods necessary for foreign designs.

(4) Lack of shipping space.

(5) Lack of equipment and organization for testing and research.

(6) Lack of definite knowledge of strategic requirements along the Front.


The S. E. 5, 1917

Against these may be set certain advantages which America now possesses and which we must recognize and put to use just as surely as we must overcome the disadvantages. These advantages may be listed as follows:

(1) Knowledge of quantity production.

(2) Knowledge of value of standardization.

(3) Mass of available data (not being put to use).

(4) *Natural creativeness.*

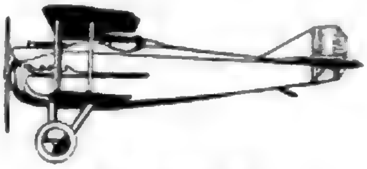
The solution of the problem by use of these assets is our immediate task. In attacking these items and setting the disadvantages against the advantages to obtain a maximum result, we must remember that time is the factor of greatest importance. We cannot take the time, even now, to learn how to design new airplanes for use on the battle front six months or even a year from now. Our present problem is to take what we have and from it get the greatest possible and most immediate result. This will not mean 100 per cent planes or 90 per cent planes; even if they be only 75 per cent planes in comparative performance, they can be of equal use to 80 or 90 per cent planes, provided they can be had in sufficient quantity.

The one and only *obvious* combination of these advantages and disadvantages is *quantity production* of types of planes already in existence in the United States, and of known performance.

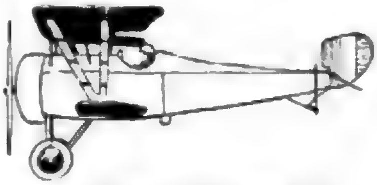
Taking the known principles of aerodynamics and performance of planes we now have and developing production-constructions—parts that can be produced in thousands a day, tied up into bundles and shipped abroad for assembly over there—thus we can solve, not only our immediate troubles, but lay a foundation for future perfection.

In developing these types of construction—which of necessity probably will be of metal on account of interchangeability—we can at once use that type of American labor found in our automobile plants in producing planes, and thus overcome another present disadvantage.

For 20,000 airplanes, 2,400,000 ribs will be required. If of the usual wood construction, this means that nearly a hundred million pieces must be formed, glued, nailed and screwed together, to say nothing of the inspection and other routine work necessary.

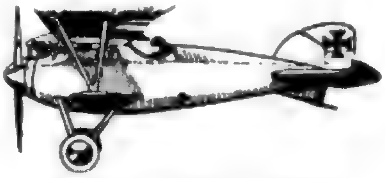

The Spad, 1917

This item alone visualizes what I mean by developing quantity construction, for if we could develop a metal rib stamped out in hundreds an hour to conform to the same aerodynamics and weight requirements as does the wood rib, we would immediately eliminate the necessity for thousands of workmen of the "violin-maker" type who might be put to the construction of other parts and thus add to the quantity possibility.


The Baby Nieuport, 1916

The more items of airplane construction that we can change from the present hand-made "violin" type of workmanship to designs that are fit for quantity-output methods, as we know them, the sooner will we complete the program which we now desire.

It is more than probable that we can place a maximum performance type of plane on the battle front more quickly by taking a design and developing it in this production way than by continuously changing from type to type every few weeks, as has been done abroad.


The Albatros III, 1917

In attacking any problem for action and for real results three steps always are necessary:

First, one must know *what to do.*

Second, he must find out by research and analysis *how to do it.*

Third, by organization and executive control, he must *do it.*

No one of these three divisions can be left out and still get really efficient action.

When the war started, America—owing to the patent situation—had small knowledge of aircraft, aircraft design, or aircraft manufacture. The firms operating were few and of small talent. To enter the airplane business at that time was merely to invest in a law suit.

Europe having been at war for some time had developed fighting aircraft, regardless of hindrances, and had seen to a certain amount of strategic possibility. In the time available, there was no opportunity for us in America to learn, more than in a perfunctory manner, just what it was we had to do. The nation and some of its patriots were confronted with the problem of handling all three divisions of action at once, being actually organized and *doing* the job at the same time that they were learning *what they had to do*, and further getting their first education as to *how to do it*.

With all this in view and the confession of a colossal ignorance, not of *anybody* but of *everybody* in America so far as aircraft were concerned, it is a great credit to those who finished the first stage of aircraft production for war that they could do so tremendous a job in so short a time.

When one remembers that within one year a mushroom organization was confronted with the task of spending judiciously more money than was spent on the Panama Canal in eight years, one has a vision of what a real man's job this was.

When one adds to this, the tremendous inefficiency forced upon the organization by past congressional acts, which bound every movement with red tape and suspicion, he sees the task three times as hard to accomplish as though the work could have been done under industrial methods of centralized trusted authority.

That to date in the aircraft program we have accomplished almost the impossible does not by any means prove that our problem is solved. We have spent the time to date learning what aircraft are and how they are being built in Europe. We have had little if any, time to absorb the necessary lessons relating to production and shipping requirements, which, as we have them, are different from those of our Allies abroad.

With the present type of airplane construction an attempt to copy foreign designs requiring foreign types of labor—we may never be the help to the Allies in the air that we wish to be. If America is to produce the cloud of ships which she has promised herself to put into the air, other means must be designed for building aircraft than those now existing.

Aircraft design may be divided into four major branches:

First, *aerodynamics* or the air theory of the plane.

Second, *structure*, which has to do with the materials and strengths of the different parts.

Third, *mechanical arrangement*, which is coupled very closely with both.

Fourth, *production design*.

A fifth, known as *accessory design*, might be added.

Aerodynamics, in its fundamentals, is very simple. There is no final necessity for complicated mathematics in working out airplane problems.

Aircraft must be designed for specific uses. If one is going to build a boat, the designer decides how fast he wants it to go, and how much load it must carry. Immediately he finds that a compromise is necessary, for if he builds a hull to give maximum lift or cargo capacity within its dimensions, he has lost speed possibilities and has produced a slow-going craft. On the other hand, if he designs for speed, there comes immediately the problem of reducing the weight of all parts, fuel and cargo, in order to get sufficient flotation within the dimensions that are required for speed.

The same analogy holds in present-day aircraft, and the wing curve of a plane is a fairly decent analogy to the boat. A deeply cambered or curved wing, of fairly thick section, gives great lift at steep angles, and is ideal for weight carrying. This type of wing curve is shown above in Fig. 1. If, however, one designs for speed, he selects a wing better stream-lined and which disturbs the air less at flat angles.

Remember that at speed the pressure on the wing becomes greater per unit of surface area, and as the pressure becomes greater, the plane flies with a smaller angle of incidence.

Thus, when the heavy lift wing, shown in Fig. 1, gets up great speed, it takes a smaller angle and offers at once a great deal of resistance to forward travel through the air. To try to make a wing of this curve travel at speed is just as sensible, as I have said before, as to attempt to crowd power onto a canal boat and turn it into a racing yacht. The addition of power will do nothing but pile up a bigger wave in front of the ship and will add almost nothing to its speed.

This has been proved in certain types of planes; we have replaced 400-hp. engines by engines of 200 hp., but as a result of double the thrust, the gain in speed was only 3 or 4 miles per hour. As a contrast to this, we have taken the same engine in a much heavier plane, but fitted with a speed wing curve, and have driven it at tremendous speeds.

This brings up one of the earliest ideas which was used to design planes for speed, and which was mentioned before the Society last year by one of the speakers[*] from abroad.

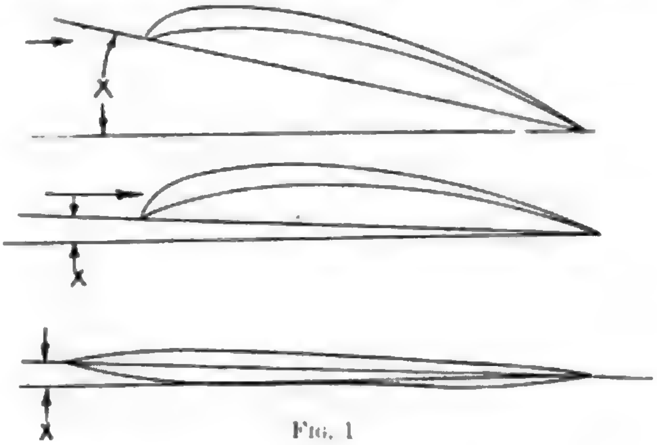


Fig. 1

Although the heavy-lift type of wing can not be driven to speed by the addition of power, yet the speed type of wing can be driven to greater lift by one or two methods, first by increasing the flying speed, which means landing speed, and second by adding greater area to make up for the loss per square foot of lift.

Racing planes, rather than having clipped wings of heavy lift, tend toward large wing areas and light loading, but with the nicely stream-lined wing curves shown in Fig. 1.

In adding this wing area one must also add more wing area to lift the weight of the wing area he has just added, which is the equivalent almost of a dog chasing his tail. The additional weight per square foot in the wing is around three-quarters of a pound, yet, on account of the extra weight of this new wing surface also, one must figure a weight of 1½ lb. per sq. ft. for all the wing surface added.

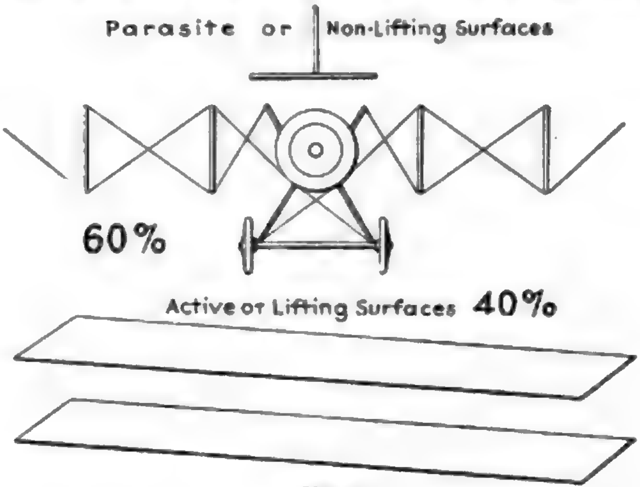

Parasite or Non-Lifting Surfaces
60%
Active or Lifting Surfaces 40%

Fig. 2

Addition of weight on the wings, however, is not of much tremendous importance if one does not increase the flatplate or parasite resistance, a point that I will explain later.

If the designer increases the weight, however, of the engine or body he must add 3 pounds to his total for every 1 pound of additional engine weight; either in extra wing structure, extra tank weight or fuel weight, or added truss. These figures are, of course, structural figures, but I give them to show how closely structural, all the way through, are connected with the aerodynamic considerations, and that in changing the aerodynamic features, one cannot for a moment forget the structural fundamentals that he must follow.

By developing the idea of increased wing surfaces and greater penetration of speed possibility on the part of the wing curve, we have been able to build airplanes of such wing efficiency that the wings have now become one of the least points of resistance at high speed, for the parasite resistance is dominant.

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[*] Wing Comdr. J. W. Seddon, R. N. A. S., Design and Production of Aircraft in Time of War. S. A. E. Transactions, Vol. 12, Part II.

Fig. 2 shows the so-called parasite parts of the airplane. These are the parts necessary for structural or operating reasons, but which offer resistance to forward travel without adding to the lift or support of the plane. They include struts, wires, landing gear, radiator, piping, exposed control wires, pulleys, body, tail surface edges, tail skid, and things which to the layman seem so trivial as to warrant no real thought. In a speed plane, however, the exposing of a water pipe from the engine to the top wing, might slow down the maximum speed of the plane 5 miles per hour. Adding stream-line wires in the place of round cables might add 10 miles an hour to the speed of the machine.

In speed planes today, at maximum rate of travel, more than 60 per cent of the engine power and gasoline consumed is used up in forcing these parasites through the air, and only 40 per cent of the horsepower is usefully used. It is as though a speed boat going through the water, and having a beautifully stream-lined hull, should be forced to run a race with a log dragging behind, or like a car in a race with the emergency brake set the whole time, wasting power for nothing.

The greatest problem today of the aeronautical engineer, both as to aerodynamics and structure, lies in the elimination of the parasite, or as the British call it, "flat-plate" resistance.

While the airplane today contains essentially the same units of structure as in the beginning, yet the mechanical arrangement has varied as new engines, materials and processes and greater experience in flying have shown the way. The early two-propeller pusher with exposed pilot and no body construction gave way to the single-propeller pusher type with the pilot seated in front of the engine. In case of a spill, however, or a bad landing, the engine had a nasty habit of coming forward through the pilot before striking the ground, for which reason particularly this type of machine was gradually discarded. Another deficiency of this arrangement was that in case of propeller breaking, which happened on the small-engined machines of the early days, the pieces of the blade were likely to cut off the rear tail structure and bring the pilot to serious grief.

Then came the tractor type of plane first shown in the Nieuport monoplane with the engine and propeller in front and the pilot just back of the wings. This type of plane has passed through a high state of development in all sizes within the horsepower limitations of one engine.

With the next new mechanical arrangement first principles were used, two propellers being placed out on the wings and *pushing* the planes. The engines were directly connected to the propellers, and were fitted on the wing. This later gave way to a similar arrangement of the engines, but with *tractor* propellers in front of the wings. Recently we have had planes fitted with many engines distributed over the wings, each with a separate propeller. Some of these machines weigh as much as fifteen tons.

Outside of engine and propeller location there are three general mechanical arrangements of these tractor planes: monoplanes, biplanes, and triplanes. These types are so well known as to need no further description. The monoplane aerodynamically is the best type of design but constructionally it is to date almost impossible. Requiring double the area in one wing for the propelling of the same spread of wing, the monoplane must either have a wider spread or a deeper chord. This decreases the aspect ratio and hence the aerodynamic efficiency. To increase the span of the machine, means structural difficulty, as the spars can only be as thick as the wing section will allow and beyond a certain span this construction cannot be built with the factor of safety required in the air. Efficient monoplanes, therefore, are ordinarily flimsy and dangerous for quick evolution, having less space and heavier wing loading than the biplane on account of structural limitations. As a result, they have a considerably higher landing speed, which again makes them dangerous except for the most skillful pilots.

A big disadvantage of monoplanes in war is the tremendous blind spot under the wings, where the pilot can see absolutely nothing. He can see everything above and out to the horizon, but nothing below him. The parasol monoplane developed with the wing above the fuselage so that the pilot can see beneath and above, gives excellent vision but compromises with center of thrust and head resistance in such manner that it is still of doubtful value.

Structurally the biplane is superior and is far less in weight per square foot, but again there is a difficulty of vision. Although the pilot can see more below, since he is farther up from the lower wing and has a narrower wing chord to hide his view, he has a second wing above him which slightly hinders his view, enabling a plane to dive on him from the front along a certain line without its being seen until it is close at hand.

Every blind spot on a machine is dangerous, especially in bombing machines or combat types, because the Hun pilot spying a machine from afar and "seeing you first," knows from the make of the machine just where the blind spot is and how he can sneak up under it or around to one side in such a position that he cannot be seen until he opens fire. In formation work one is not permitted to circle around in order to retain his vision in all directions. Over enemy territory, it is important that the pilot keep his place in the formation, traveling and reducing speed with it.

A man in a formation over enemy territory who misses his place in the line and for any reason falls behind is much like a ship which in a convoy crossing the Atlantic has engine trouble and falls away from the protection of the battleships and destroyers. One never knows when a speed scout flyer is hiding in a cloud. The Huns follow a formation fleet across-country as submarines follow a convoy, and pounce at once upon any plane that drops behind to an unprotected position. If one flyer on the fringe of the formation can by attack be forced to dive away from his fellows, he is immediately at the mercy of the Hun scouts, who will not come too close for fear of receiving the combined machine-gun fire of the squadron. If there is a blind spot in the machine, it is possible to force it out of formation.

To permit better vision and also in an attempt to decrease head resistance by the elimination of struts, the triplane has been used extensively. In this type the wing span can be fairly narrow, enabling the machine to land in confined places. The wings are so narrow that the pilot's view is almost complete, while the tail construction is small and short, allowing greater agility for air flights and less chance of the enemy flyer hiding where he cannot be seen.

There is no decision as yet as to which is the best type, but in analyzing present-day problems one can suggest the following lines of experiment with each type of machine:

1. How can we overcome the visional and structural disadvantages of the monoplane in order to acquire the aerodynamic advantage which we must admit the bird type of plane possesses?
2. How can we develop the biplane for less parasite resistance and greater vision—although this type is today in a higher state of development than any other?
3. How can we obtain greater aerodynamic ability of the triplane to fit the decided structural advantages which it possesses?

We may thus run the gamut of experimentation from aeronautics to structure and back again in these three types of planes alone. And there are others unthought of.

Following the discussion of present possibilities and requirements in airplanes for war and of the next steps to fit what we know to the requirements of today, it is worth while to look ahead to see what the future offers in the eventual development of aircraft.

In the development of the automobile not one-hundredth of the money per month was spent in perfecting models and ideas that is now being spent on airplanes. New automobile models were brought out annually and were in the experimental stage for months.

New airplane models must also go through these months of experimental work, but on an average new models and types are taking precedent on the battle front every eleven weeks.

The automobile industry has developed materials and processes, parts and types of organizations through years of effort. In developing aircraft we have all of these related industries and organizations to draw on for knowledge and material. We are thus able to move in development work *five times as fast* as was possible with the automobile, a fact which is worth more than passing thought. This means that the man entering the aircraft industry today ***must think five times as fast*** as the automobile executive, in order to keep up with the industry, and that an engineer must have five times as much vision and mobility of mind in order that he may keep his place in progress.

A very fine line must be drawn between conservatism, as we have known it in other industries, and what we call conservatism in the aircraft industry. What would be reckless judgment in established industries might well be ultra-conservative judgment as related to aircraft design. It is largely for this reason that during the war period the business man of the old type has been so quickly eliminated from this new industry in favor of that type of man who thinks quickly and fast, and is willing to take long risks, trusting to his own judgment. This type of action necessitates great mistakes as well as great successes.

The British Air Board, for example, was changed five times in the first year of its existence, largely, we are told, because the industry grew faster than the vision of the men then in the Air Board could follow. This work is now entirely in the hands of one man, and a man of quick acting vision and definite commercial experience. That our own program is taking similar form, so far as organization goes, is one of the most encouraging items of today.

This type of vision naturally requires that research follow every available idea, and research is but a way of "wasting money intelligently." Tremendous sums can well be spent during the next few years in developing aircraft for war, remembering that a day of war saved means a gain of fifty millions of dollars and six thousand lives.

With these ideas in mind it would be well to conclude this analysis with visions fanciful as we can summon to mind, which still are based on sound engineering judgment. From this viewpoint I predict that operating speeds will exceed five miles a minute in airplanes before we can call aircraft really developed machines.

I have discussed the parasite or flatplate resistance as being a fundamental defect of aircraft. Fig. 3 shows the parts that at high speeds now form the greater part of such a loss.

The solid area in the curve, Fig. 3, shows approximately maximum performance to date. The ordinates indicate the horsepower required; the abscissas designate the miles-per-hour of speed. It is evident from this that above a certain point additional horsepower does not give an equivalent addition in speed, so that even should we trouble the horsepower of engines of the same weight we would not materially increase the flying speed of a plane as built today, although we could reduce its landing speed.

It is possible to operate wing sections efficiently at a speed of 8 *miles per minute*, as is proved by propeller tips on machines flying at present. These tips in our Liberty planes travel 8 miles per minute, and their efficiency is nearly 85 per cent. There is no reason, from a pure engineering standpoint, why curves in the form of wings cannot perform equally well. The fundamental difficulty is in landing, for although it should be possible to build a machine today to fly at almost any speed we want, yet the landing problem is so great as to make real speed prohibitive.

If we learn from the German long-distance gun, which sends its shell up from the earth to a point where the atmospheric resistance is negligible, we may also send airplanes to equivalent altitudes, with special engines developed for that work, and thus in a much lighter medium, with less resistance, obtain our speed range. This will require the solving of many problems. It will mean new propelling apparatus, or propellers. It may even mean special fuels to be used at altitude.

There are various ways of attempting the problem and as we are gaining experience through actual work at 20,000 feet and over, it is possible and even, in my opinion, probable, that long-distance travel in the future will take place at altitudes more than five miles above the earth's surface. It is as though a ship on the ocean could pick out for itself water of varying density, so that for speed work it would take a medium of less resistance; or to use another analogy—it is like the seaplane, which when its operator really wants to travel fast rises from the water and ascends into a lighter medium, even though this lighter medium requires greater supporting area. In altitude work, however, this necessity for greater area will be compensated by the greater speed, which is the fundamental desire.

And so we come to the problem of landing. As soon as we have a plane that we can force to travel at high speed (see the dotted possibility line in Fig. 3) landing will become a dominant problem. We ordinarily visualize safety in landing as depending on speed alone, but speed is only one of the elements of safety. That real safety may be had *three* things are necessary:

1. To land within the smallest possible area.
2. To land on the roughest possible ground.
3. To touch the ground at the slowest possible speed.

Eventually airplanes will land almost in their own tracks, much as a pigeon lands on a window sill or a sparrow on a wire.

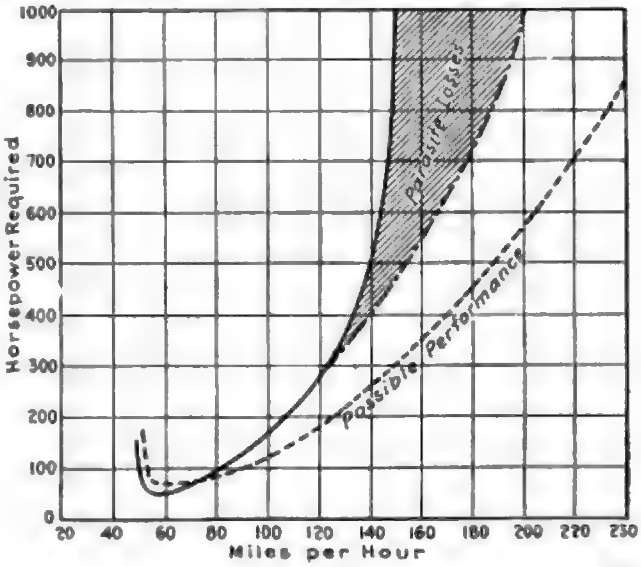


FIG. 3

It is by no means proved that our present method of landing airplanes is the final one, and intensive study should be put on the development of new landing systems and schemes, that greater things may be accomplished.

In analyzing landing and any one factor concerned with it, the other fundamentals should be kept in mind. Modern speed planes, for example, landing at 50 m.p.h., need a large field in which to alight, on account of the angle at which they come down and the distance they roll after striking the ground. The airplanes used in the early exhibition work flew from and landed in ball parks and four-acre lots, in comparative safety. Present-day machines cannot do this on account of the necessity for speed.

Here is a thing that we know can be done, and efforts should be made to increase the landing capabilities and safety of existing planes. All three landing fundamentals require separate study.

Speed in landing is largely a question of wings and their loading per square foot. A plane with a heavy wing loading lands at a higher speed than one with light wing loading. A plane that leaves the ground at low speed generally is hindered in its high-speed flight, and an airplane is too fast to fly only when it lands at a speed that is too great to be safe. Once in the air, flying at a high speed is not a problem but an advantage.

If landing speed can safely be increased to higher limits, then the maximum speed of the plane can be increased in proportion.

Planes with surfaces that are small for their weight glide at a steep angle and come down fast. After they have touched the ground, however, their air resistance quickly stops them.

Planes with light wing loading "float" very easily, coming down to their landing place at a very flat angle. They must travel a considerable distance over the trees before touching the ground and, although they touch the ground at comparatively low speed, they roll a long distance before coming to a stop.

Not long ago I was interested in seeing a landing made by a pilot who had a plane of the "floating" type out for the first time, and who was unused to a machine of light wing loading. He made a beautiful landing in the center of the field, though at a higher speed than the plane was designed to land at, although at the landing speed he had been accustomed to in other planes. Once on the field, however, he had acquired so much momentum that the plane went on and on, across the field until it struck the fence on the far side.

Fig. 4 compares the landings of the slow-speed and high-speed types of planes, it being seen that the high-speed plane, although it strikes the ground faster and at a steeper angle, comes to stop more quickly and can land in a smaller place.

A machine of light wing loading, coming into the field over the trees as shown, must float a long distance at a flat angle before it strikes the ground. If the pilot nose the machine down sharply over the trees, by the time he has lost sufficient altitude to flatten out he finds himself making a high-speed landing, so that the fact that his machine can land at slow speed has done him no good. After he strikes the ground, as just explained, he runs a tremendous distance, and is in great danger of breaking the machine, although with small danger to himself on account of the comparatively slow speed.

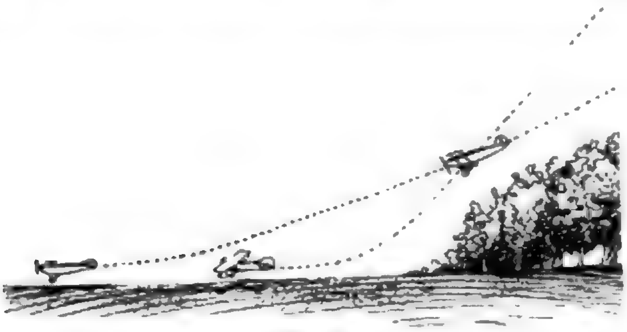


Fig. 4

The problem then is not entirely one of landing speed. No matter what speed the plane lands at, within reason, if the wheels strike no obstruction, the landing is a safe one. If, however, at high speed they strike a hole, or a ditch, or a rut, there is a tendency for the machine to nose over, or even turn a somersault, to the great danger of its occupant. This danger is, of course, less at a lower speed. In other words, in an emergency landing with a high-speed landing machine there is really less danger of running into objects bordering the field. There is danger, however, of nosing over, if the field is bumpy.

With a machine landing at high speed one can see that having the weight close to the ground would be a considerable advantage, a point that has been discussed somewhat in connection with mechanical arrangements. This indicates a requirement in engine design that has been lost sight of during the early development period when engineers have been learning the fundamentals of aircraft design. This requirement is that the center of thrust due to the engine should be high, or stating it in another way, that the center of weight of the engine should be low, and coincide as nearly as possible with the center of thrust of the propeller, which is, of course, at the engine shaft.

If the center of gravity on an airplane be low, then the striking angle from the point of contact of the wheels to the center of gravity of the plane, Fig. 5, will be considerable. If this angle is small there is less danger of nosing over. If it is nearly 90 deg. then there will be a great danger of a somersault, hindered only by the area of the tail surfaces. A requirement for safe landing, therefore, is a low center of gravity, and large area and leverage of tail surface.

With the floating type of slow-landing machines there is just as much risk of accident with the machine but less danger to the occupant on account of the slower speed.

There is real opportunity for study and research to devise such mechanical arrangements—different from those now in use—as will enable higher speed landings to be made, and with quick stops.

This might be accomplished with a brake, on the floating type of machine. An air brake will not do, as at the slower speeds it would have to present, presumably, too great an area to be effective. A ground brake will not entirely do, because at the time the machine first touches the ground the pressure on the wheels and skid is so small as to be almost ineffective. To apply brakes to the front wheels would be like striking a bump, and would probably mean a spill.

I am not stating how this problem of landing is to be solved. I am merely mentioning it as one of the present-day problems of aeronautics that we can well consider as of first importance.

In studying landing remember that if we can add 10 m.p.h. to our landing speed we can add 20 miles or more to our flying speed. The ideal machine, of course, will be one of sufficient area to make a successful "pancake" landing, but machines with wing loading light enough to accomplish this feat are, with our present knowledge of structure, not within reason.

This brings us to the accessory parts of an airplane, some of which need to be redesigned and others will probably be eliminated.

The landing gear might be called an accessory, and very shortly this will be of the folding type, so that the head resistance can be eliminated, or at least partly so, as soon as the plane has mounted into the air. To date no experiments have developed a structure strong enough and light enough to do this.

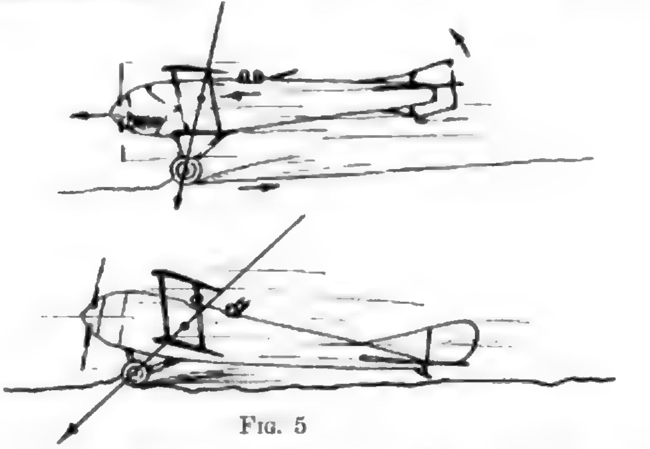


Fig. 5

The matters of armament, or wiring, or carburetion, and of instruments are being taken up, but in spite of their extreme interest have no place in a published discussion at this time.

It is very probable, however, that the airplane will before long be a more accurately navigated vehicle than the ships of the sea.

Very little trouble is had with engines today, either in aircraft or automobiles, and little trouble with planes or with automobile chassis. The main difficulties come in connecting the two; in putting the engine into the plane or the car. As I have stated, we are now getting a great deal of experience in making these connections.

The greatest difficulty, as concerns gasoline engines, is with the radiator. In order to function properly this must have air and plenty of it, and yet must be so arranged as to offer, theoretically, no resistance to forward travel. It must cool successfully on the ground at 100 deg. in the shade, and within twenty minutes meet the same requirements at zero weather and high altitude.

Recent developments in air cooling indicate that for certain types of machines a great deal will be done with engines without radiators, there being particular advantage in air cooling for aircraft, in that moderate temperatures are always available at the high altitudes at which one ordinarily travels.

The heart of the airplane is undoubtedly the engine, and with this great progress has been made. All discussion of planes themselves, however, has shown that the engine in spite of all has comparatively small influence on speed-range performance. Weight per horsepower rather than total horsepower counts in an airplane, and this also must include the fuel necessary for the type of work that the plane is to do.

Planes with engines of 40 hp. are practically equivalent in climb and speed to planes with five times that engine capacity. The difference comes in the amount of load that can be carried, which again indicates the distance that the plane can travel without refilling the fuel tank.

It is just as foolish to expect a bomber machine to go faster and to be more agile than a speed scout, even with its tiny engine, as it is to expect an ocean freighter having engines of tens of thousands of horsepower to outdistance a speed boat with only a small gasoline engine. The difference in cargo capacity, however, is tremendously in favor of the bigger-powered ship. The same is true in aircraft, and as progress leads the way and experience dictates, aircraft probably will become larger and larger even for speed performance. Each design will be specialized for its own particular work and having engines of maximum horsepower to fit the maximum load requirements.

The engine, since it was begun in the automobile, is a line of effort in which we have already accomplished much in this country. It is one of the few parts of airplane research on which we had data at the start. We have learned much about aircraft engines, however, in the last year. We have learned a number of dynamic requirements which the automobile engineer has never met or had experience to analyze.

Experimentation with engines during the past has followed two major lines: the first aiming to produce an engine of lighter weight for the same horsepower, the second to greatly increase the horsepower for the same weight.

The first school—having its beginnings really with the Gnome rotating air-cooled engine—has developed rapidly, but has been hindered in obtaining high efficiency per cubic inch, in spite of the great number of cubic inches per pound of material. In the second school, on the other hand, as represented by the automobile type of engine, the weight per cubic inch has not been materially decreased, except in proportion to the cubic inches added to the engine, but the power obtained from each cubic inch of cylinder displacement has been tremendously increased.

In the school of engine design now coming into prominence the advantages of the lightest mechanical arrangement are being combined with the better theoretical construction of the automobile type which obtain the greatest power per cubic inch; this school is thus designing what must be very nearly the eventual type of engine, while aircraft are in the form in which they exist today.

One of the most prominent factories manufacturing rotating engines has been turned over to the manufacture of stationary radial engines, this seemingly being the beginning of the end for rotating aircraft power plants. Radial non-rotating engines of both air-cooled and water-cooled types are worth a great deal of effort today.

Receiving attention in all countries is the finding of some method by which an engine can develop its full horsepower at high altitudes. There are many methods of approaching this problem, and undoubtedly ways will be found whereby powers can be had at altitude equal to those obtained on the ground. Up to date, little has been actually accomplished along this line.

The chief difficulty in obtaining power at altitude is in keeping the proper amount of oxygen in the mixture and the proper initial volume of intake gas in the cylinders. Many methods of pump or turbo-compression and supercharging devices of one kind or another have been suggested, but up to date nothing has been accomplished.

And so I might go on through many fundamentals that have not even been touched on in this paper, and which involve new lines of research and study in materials and processes and the minutest details of construction. Enough has been presented, however, to establish those things that are basic in the future development of planes, and to start discussion to bring out further requirements and possibilities.

Today we know aerodynamics in America. We know production. We know what to do, and we know, in a large measure, how to do it. The problem is, then, first, to organize the efforts of this Government and this Society so that planes of production construction can be turned out in thousands, in knocked-down form for concise shipment, and gotten as soon as possible into action on the firing line; and, second, to devise new maximum ideas for the next step. Since America is at such a distance, and cannot hope to produce the latest maximum-performance plane at once, she must therefore at present make up in tremendous quantity for what she may lack in individual quality, believing that a thousand 75 per cent planes are better than a hundred 90 per cent planes, or one perfect plane still on the drawing board.

When the engineers on this type of work have accomplished the result, and our planes are going over by the hundreds each day, and after we have the experience as well as the book knowledge of the intimate problems of aircraft creation, we will be ready for the next step: by American ingenuity to build those new planes and more ideal constructions that shall mark the end for Germany in the air.

We are living at the most interesting period of the world's history. We are facing the greatest opportunity that the engineer ever has had for achievement. Europe, recognizing in us the country that has created the submarine, the airplane, the steamboat, and the present major instruments for war, looks to us also, to the country of Fulton, Bushnell, Edison, Langley, Chanute and the Wrights, to create, with the Yankee cleverness which they recognize, the final air instrument for "strafing" the Hun. I am glad to say that America is rising to the occasion, and that our engineers are meeting the situation with remarkable success. Untold numbers of new devices of genius, scientific, accurate and wonderful, are perfected and almost in production, for the demoralization of our enemy, and we can feel confident that every problem that has been given the American engineer will surely and quickly be solved to the point of action.

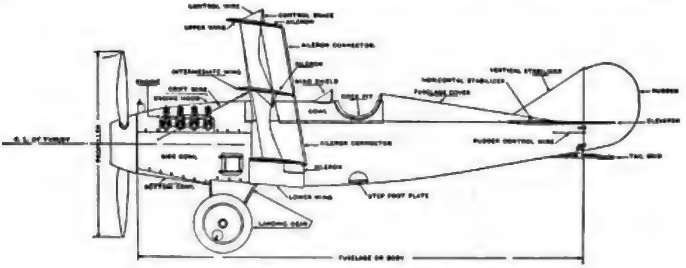
Today a world picture is being painted, the background of which has been done blood red by the gory hand of Mars. The paint is not yet dry, and in looking at it one sees only red. There is a foreground, however, which civilization is now painting in delicate colors but with bold strokes, picturing a future of peaceful commerce and generations of happiness. Eventually the background must be covered, but for the time being, while sketching in the detail of that foreground which will be painted, progress seems slow. When the picture is done, however, and the primitive red shall be replaced by the delicate tints of dawn, by the green of the trees and the reflection of silent waters; and when at last the Painter shall lay aside his brush and step back to look over on the new world, may he see, through the foreground of happiness and peace and contentment, that middle background of achievement and sacrifice and conscientious judgment with which we are now concerned, as having enabled the foreground of Peace to obliterate the background of War, that Life might take the place of Death, and Love of Hate.

FRONT VIEW OF A FARMAN TWO-SEATER BIPLANE, WITH A 220-HP. LORRAINE-DIÉTRICH ENGINE face. It is also a significant fact that the force required to move a small wire through the air is as great as that required to move a stream-line strut several times its diameter. The influence of the stream-lining was formerly little understood and seldom taken account of in the design of struts, body and landing-gear. Scientific experimentation, however, revealed the necessity of cutting down head resistance, thus decreasing what is known as the "drag" or "drift." It indicated the necessity of changing the surfaces, the cross-section of the wing panels, the sections of the struts and other exposed surfaces, to forms which would offer less resistance.

Effect of Stream-Lining

It is easy enough to push a thing into the air, but it is hard to get it out without creating a disturbance. If we take a broomhandle, for instance, and sweep it through the air rapidly, we find, if we could examine the air immediately following it, that a small vacuum is created just back of the stick itself, and that eddying occurs directly behind it, creating a V-shaped partial vacuum which decidedly increases the total power required to move the stick through the atmosphere. It was early found by experimenters that by filling up this vacuum, and changing slightly the entering surface, the stick could be passed through the air much more easily; a considerably smaller amount of power would be required to move it.

Now, when we design an airplane we know before it goes up into the air almost exactly what it will do. We know, for instance, that a certain type of wing-form has certain characteristics: one is good for weight-carrying, another for speed, still another seems to combine successfully several desirable characteristics. Investigators have also discovered that what is known as an "end-wash" on a wing panel can be eliminated by cutting off the corner of the panel as indicated in the accompanying illustration.



Side Elevation of the Curtiss Pursuit Triplane

Most American and Allied machines use that type of panel in which the end edges form an angle, the apex of which points to the front of the machine, but Bleriot has used a type of panel in which the angle formed by the end edges has its apex at the rear of the machine. Both types of panels have shown good performance. This latter type of end section is known as the Bleriot end. The angle at which the wing panel meets the air is another subject of wide interest. The angle of incidence, for instance, which is the angle between the direction of flight and a tangent drawn through the lower surface of the wing panel, may be varied with interesting results.

Of course, the whole object of all this work is to decrease the "drag" and increase the "lift"—in other words, to secure a large "lift/drag," or efficiency ratio. Drag is always concommitant with lift, and is a measure of the waste energy that is spent in order to accomplish work. We cannot get lift without drag. Lift is a measure of the effective work, and drag is a corresponding measure of the amount of work absorbed or lost, and at the expense of which we get the lift.

A biplane, if the wings are not staggered, is about 82 per cent as efficient as a monoplane of the same total wing area. A triplane is about 60 per cent as efficient for the same wing area. Taken at an angle of 4 deg., the following are the parts of the load carried by the planes: Upper, 0.45; middle, 0.20; lower, 0.35. A monoplane has 1.22 as much lift as a biplane and 1⅔ as much lift as a triplane. A biplane has 1.36 as much lift as a triplane. All of these ratios are on the basis of equal areas. The effect of stagger is to increase the efficiency of a biplane (relative to the monoplane) from 82 to 87 per cent, depending upon the stagger. For general purposes an aspect ratio of six is used. Fast racing machines usually have an aspect ratio of about six. For slower, weight-carrying machines, an aspect ratio of about seven or eight is used. The aspect ratio of the JN-4D is 7.3.

Some investigations made on dihedrals indicate that a considerable degree of lateral stability can be obtained by the same angle that would ordinarily be the result of sweeping back the wings. A somewhat superficial consideration of two or three wing sections may at this point be welcome, for instance:

Front View of the Curtiss Pursuit Triplane

The R.A.F.-6 (curve No. 1), developed by the Royal Aircraft Factory under O'Gorman, has been found both by wind-tunnel prediction and by actual tests in the field, to be one of the best lifting cross sections at a fair rate of speed. It has a fairly large range of stability, which is desirable in a machine flying at a normal rate of speed and with a considerable load. It is used in many of the heavier training machines. It is an excellent curve for hydro-work, inasmuch as a hydro-machine is generally heavier than a land machine for the same purpose.

The Eiffel 32 cross section is of a generally slender form, which gives a fair lifting capacity and also a considerably greater speed than the R.A.F.-6, with the same expenditure of power and carrying the same load; the reason being that this curve is somewhat better stream-lined. Of all the curves that Eiffel has developed, the Eiffel 36 is considered the best. While the lifting capacity at the same speed is not so great as that of an R.A.F.-6 curve, its resistance at the same speed is considerably less. Therefore, with the same power at our disposal we can actually pull this curve through the air at a greater speed, and hence obtain the same lift with lesser area. On account of this, it is a faster wing section than the R.A.F.-6.

Scientists and the military authorities have developed and are today using curves that excel in all points of performance any of the three curves above mentioned. If the R.A.F.-6 curve, for instance, be said to have 15 as a factor of merit, and the Eiffel 36 be credited with a factor of merit of about 17½ to 18, we are using curves today whose factor of merit is about 22.

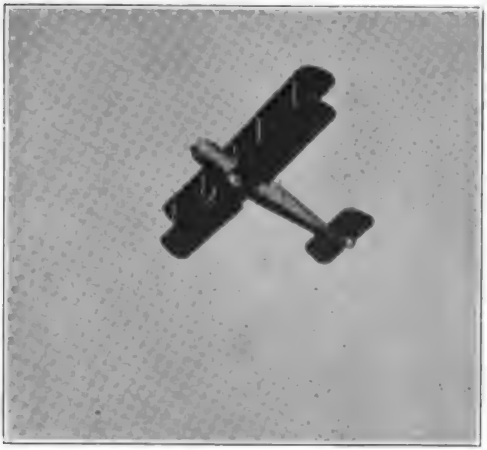
Classification of Machines

Modern airplanes may be divided into the following general types:

(1) *Combat Machines.* These are small, very fast, single-seater fighters, used for scouting purposes. They usually have wing spread of from 20 to 25 ft., a speed of 125 to 135 m.p.h., carrying capacity of 450 lb., and a climbing speed of 10,000 ft. in from 8 to 12 min. The Spad, Nieuport, Morane, Curtiss-triplane, SE-5, Sopwith, Dolphin and German Albatros single-seater are examples of this type.

(2) *Reconnaissance and Photograph Machines.* These are a slower flying machine intended for reconnaissance and pho-

tographic work. They are used for artillery spotting, map making and general reconnoitering. The wing spread is usually from 40 to 60 ft., and the speed from 80 to 100 m.p.h., the carrying capacity from 800 to 900 lb., the machines being two or three seaters, and having a climbing speed of 10,000 ft. in 12 to 25 min. Examples of this class are: De Haviland, Bristol, Curtiss, Voisin and Farman.



A D-H.-4 Fitted with a Liberty-12, as Seen from the Ground

(3) *Battleplane.* The battleplane is a two or three-passenger machine driven usually by one large or two fairly good-sized engines, and equipped with a number of machine guns and sometimes with a cannon. It is a moderately fast machine, making from 70 to 85 m.p.h. The Voisin is a good example of this type. It is credited with carrying a one-pounder.

(4) *Bombers.* These are of the same general type as the reconnaissance machines, but slightly larger. They vary in size from 45 to 90 ft. in wing spread, and carry from two to twelve people in addition to their war load of bombs and fuel. Their speed is from 75 to 100 m.p.h., their radius of operation from 500 to 1000 miles, and their climbing speed 7000 ft. in 30 min. Examples of large bombers are: Handley Page, Caproni, Breguet, the Caudron (a twin-engined French machine), the German Gotha, the Friederichshafen, the German AEG, and the big Curtiss boats. Machines that have been used for day-bombing and other purposes, but have lost their "pep" in remodeling, are many times used for night-bombing.

Bristol Monoplane

(5) *Flying-Boats and Seaplanes.* Various sizes of these are used for naval work. On account of the weight of their hull or pontoons these machines compare favorably with reconnaissance machines traveling at as high speeds as 90 to 100 m.p.h. Used for coast patrol work and for naval observation purposes, they operate from stations on the coast, battleships or motherships that accompany the fleet. Hydroaeroplanes are similar in construction to land machines, except that in place of the landing-gear, single or double pontoons are fitted below the wings so that the machine may rise from or alight on the water. Most hydroaeroplanes are lighter than flying-boats. For that reason, where a craft is desired for inland water work or for short scouting trips, the hydroaeroplane is considered by many to be a very desirable type. Unlike the land machine, it is not necessary to fly high in order to pick out a suitable landing place; one can land on the water almost anywhere. For larger sea voyages, however, especially when it is necessary for the craft to remain for some time away from its base of supply, a more seaworthy type of hull is necessary.

The large flying-boats, which the Curtiss Company has built in large numbers, are good examples of this type. These boats have a wing-spread of about 90 ft., are about 46 ft. long, and have a hull shaped very much like a sulphur-bottomed whale. The hull is 42 ft. long, the inside is electric-lighted, completely equipped, and so arranged that one can move about comfortably. A boat of this size will carry a little more than 2000 pounds. I have been told by English officers that this boat has given a good account of itself, and that a large number of pilots have been decorated for their splendid work in attacking and downing Zeppelins in the Channel.

Bristol Biplane

Conclusion

American manufacturers are not standing idle as some people seem to think. There have, of course, been many discouraging delays—many of which might have been prevented, many of which could not. I believe, however, that we are now fairly well on our way to good and continuous production.

Americans are known as great manufacturers and great inventors. American inventive genius always has, and I believe always will, continue to lead the world. Out of the brain of the Americans came the airplanes of yesterday and out of their brains will come, I believe, hundreds of improvements that will make the airplanes of tomorrow equally radical in their epoch-making possibilities.

We will win this war; why? Because it is a war of democracy against autocracy, a war of mental freedom against mental domination, a war of right against wrong.

Right will conquer, it always has and it always will. Humanly speaking, this war is a mechanical war, a war to be waged and won with machines directed from the air. It is a war that our *red*-blooded young men, in whose hearts has been kindled the *white* heat of true patriotism, flying in the *blue* sky of an ever-increasing democratic world, will, with the help of Almighty God, fight to a glorious and victorious end.

The Orville Wright Banquet

C. F. Kettering, president of the S. A. E., acted as toastmaster of the banquet given in honor of Orville Wright, at which speeches were made by Howard E. Coffin, Colonel E. A. Deeds, Colonel J. D. Vincent, Lieutenant M. Miozzi of the Italian aeronautics commission; F. G. Diffin, assistant director aircraft production; C. M. Manley, member of the American aeronautical commission to France, and Dr. S. W. Stratton, director national bureau of standards at Washington.

Fred Rike welcomed the visitors on behalf of the citizens of Dayton as follows:

"I certainly must welcome the privilege as a citizen of Dayton of expressing our pleasure at having this meeting in our midst, and this afternoon as we stood over in the field here and watched the performances of the tractors, and then watched the performances of the battleplanes, it made cold chills run up and down my back, as it must have made the chills run up and down yours, and I felt that it must be a wonderful moment of satisfaction to our foremost citizen, Orville Wright, to see the fruition of the idea that he and his brother conceived and worked out, and it is a proud moment for Dayton on that account, and a proud moment for Dayton on your account. We hope you will come again."

Mr. Kettering then introduced Orville Wright, saying: "Our next speaker is a very linguistic sort of gentleman and is prone to talk too long. Therefore we had his speech printed in advance, but in order that you may understand it thoroughly I want to introduce to you our guest of honor, Mr. Wright." (Applause, the audience rising to its feet and indulging in prolonged cheering. Mr. Wright bowed his acknowledgment, but did not address his audience.)

ORVILLE WRIGHT
Photo W. P. Mayfield

Mr. Coffin's Speech

Howard Coffin was the next speaker: He said in part:

"There is one phase of aircraft work of which nothing has been seen here today, but to which the Aircraft Board's advisory relations were just the same as to the Army's activities. I refer to that of the Navy. The Navy has been building battleships and destroyers and telling us about how submarines have been sunk, but we have not heard a word about aircraft, and yet in many ways the Navy has done the most remarkable work along that line. They are flying every day aircraft weighing up to eleven or twelve thousand pounds, and equipped with engines of from four hundred to a thousand horsepower and carrying crews of five men. Commander Colburn has just told me that within the last week two of these Liberty engines were taken from stock, put into a stock boat, flown up and down the river a couple of times to make sure that everything was all right, and then a trip was made of some 280 miles, from Philadelphia to Newport News, without missing a "shot" on either engine. I have seen them doing this sort of thing right along, and they think nothing at all of it. They are making almost daily trips from Newport News to Washington.

"When we consider the size of these boats and the power being put into them, we must wonder just what the limit in aircraft development will be. Of course, the Army is also at work on large machines, but the Navy, because of its work in detection of submarines, has started immediately with the large sizes. The new Naval Aircraft factory at Philadelphia has a floor space of about three-quarters of a million feet, and the work being done there is something that every one ought to see.

150,000 Men in Training

"Some 150,000 men are in training in the aviation service in this country, and there are twenty-five or thirty of the big training stations in operation. A laboratory in operation here in Dayton is one of the most remarkable developments of the whole air service; and perhaps most important of all, the mystery of aircraft production has been thoroughly exploded.

"Plants in this country are producing, and others will produce, aircraft of standardized interchangeable designs nearly as freely and easily as American plants have ever built automobiles. Those who visit the Dayton-Wright plant will see a fine example of this work of interchangeability of parts. Airplanes are being shipped from this country in a disassembled form without markings. The crates, when received on the other side, can be opened and the parts assembled without any regard to the building operation on this side, and, as I remember, a cable received only a few days ago stated that within a few hours of the receipt of a certain shipment upon the other side, planes were assembled and the engines running.

"That is the way in which America will build airplanes. It has taken time to build the tools and the fixtures that have made it possible to manufacture interchangeable parts. One may realize what engine and airplane construction mean when it comes to keeping these machines in operation at the front, because no matter how many airplanes we ship to Europe, if the interchangeable repair parts are not there, and if the men skilled in maintenance are not on hand, the machines will do us little good. We have heard a great deal said about the possible time loss in developing an American engine when it was seemingly perfectly simple and easy to adopt foreign engines, bring them to this country and put them in production, but if any one will show me an institution in this country that has adopted a foreign engine and put it into production in less than one to two years, then I will grant that the argument may have some force.

Liberty Engines

"After analyzing the situation and past experience from start to finish, it was decided that American engineers working in the American way, and with American machine tool designers working with these engineers, results could be gotten months earlier than if foreign engines were put into production in this country. I think it is a fact that can be borne out by any representative of the British service that after three years of war, with some ten thousand men in the main works, the leading British company is producing fifty engines per week, each develops fifty horsepower less and weighs one hundred pounds more than the Liberty. Now that gives a little insight into some of the arguments leading to the design and putting into production of the Liberty engine. It is America's purpose to build engines not only for our own Navy, our own Army, but for foreign countries as well. There is a great difference between fifty engines a week and fifty to one hundred engines a day, an output any one of a half dozen of the plants of this country plan to be producing inside of the next ninety to one hundred and twenty days.

C. F. KETTERING

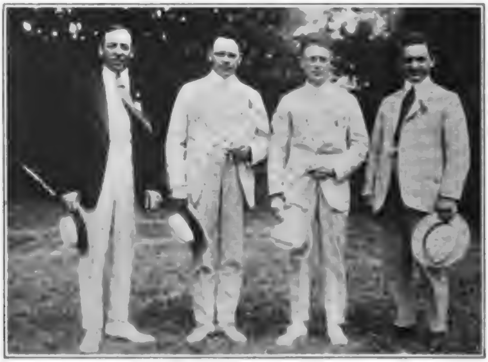
"Leaving aside all such accomplishments as increasing the spruce and fir production to some 15,000,000 ft. a month, the construction of the flying fields, the building up of personnel, the building of plants for the production of chemicals, the building up of industries for the production of accessories—those who have seen the planes on exhibition and who will see them at the Dayton-Wright plant will learn that the engine and the airplane are perhaps the simplest parts of the job. The wireless, wireless telephone, bomb-dropping apparatus, oxygen tanks for breathing at high altitudes, electrically-heated clothing, generators, flares for landing at night, scientific instruments for recording speed, altitude, inclination, and a half dozen other things, synchronized machine guns—practically none of these were produced in this country a year ago. An industry has had to be created in almost every instance. Just leave aside all these matters and perhaps three major things have been done. One of them is the development of the Liberty engine. When I say development of the Liberty engine, I mean, as Major Vincent told us in January, the production of a Liberty cylinder which would be so perfect that it might go through the war without change, and which could be used in any number or combination of cylinders on such engines as it might be decided to build. Let us call the Liberty engine one accomplishment.

Douglas Fir Better Than Spruce

"We have heard a good deal lately about the Irish situation in England, and that the linen situation was tied up with it. The English aircraft production was dependent upon this supply. The development in this country of a substitute for linen made of Sea Island long staple cotton, which has in actual test been proved the superior of linen, is another of the great influences in the development of aircraft and the participation of aircraft in the war.

"A third one is one that we perhaps had to force upon some of our Allies. Because of the spruce shortage we insisted that satisfactory aircraft could be built of Douglas fir. By force of necessity our Allies were obliged to begin using Douglas fir. The latest experiments have shown that Douglas fir is not only the equal of spruce, but is probably the superior, so that very much of the spruce difficulty will be removed.

"It has been an unfortunate handicap to the air services from the beginning that the matters of censorship have been so exercised that the truth of the difficulties and accomplishments could not be told. This very fact, I think, has been largely responsible for most of the exaggerated stories which have certainly been contributing causes to the misunderstanding of the situation now existing in many sections of the country."



MESSRS. ERICSON, PEARSON, DUFFY AND ASHWORTH

General Kenly's Remarks

"It is a great honor to have Orville Wright with us here tonight. I had the pleasure ten years ago of seeing the original flights made by the first Wright machine. Of course, in the brief period a marvelous advance has been made in aeronautics.

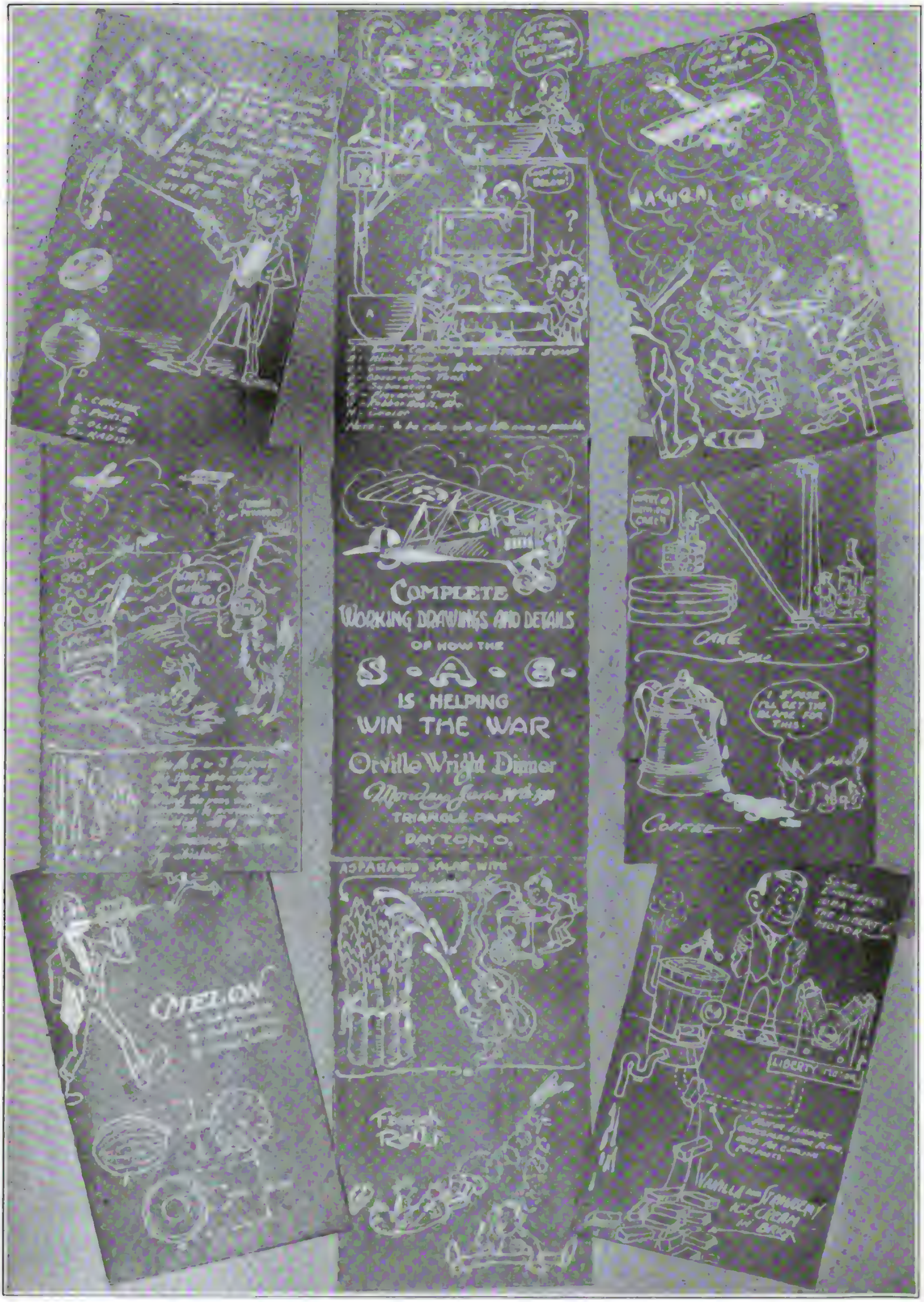
"I don't know whether you gentlemen are aware of the restrictions of the War Department upon what officers say in public. We are not supposed to say anything to anybody

HOWARD COFFIN

COMMANDER RICHARDSON

MAJOR HALL

F. G. DIFFEN


A - CELERY
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C - OLIVE
D - RADISH
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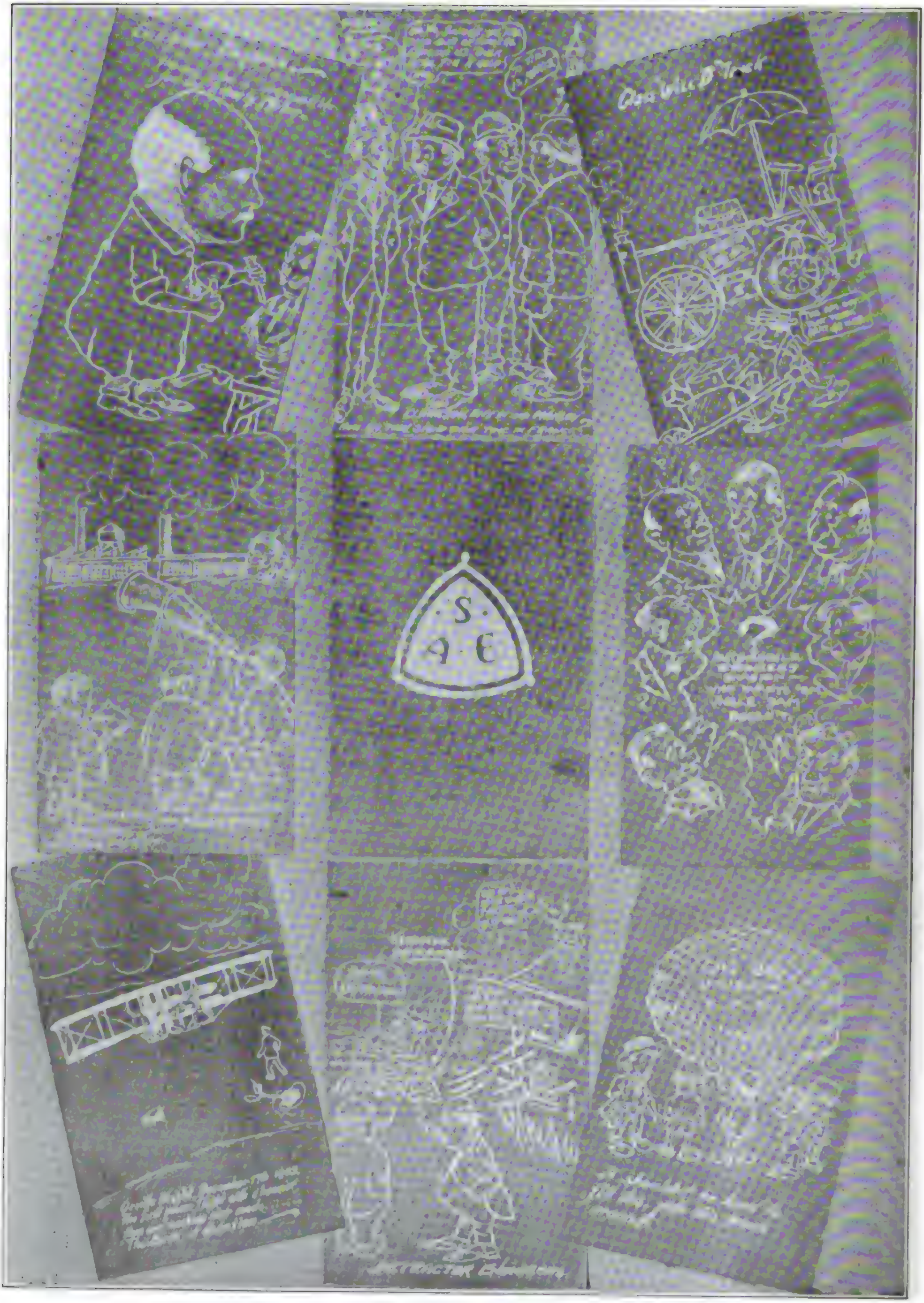
WORKING DRAWINGS AND DETAILS
OF HOW THE
S - A - E -
IS HELPING
WIN THE WAR
Orville Wright Dinner
TRIANGLE PARK
DAYTON, O.
CAKE
I S'POSE I'LL GET THE BLAME FOR THIS.
COFFEE
ASPARAGUS SALAD WITH
MELON
French Rolls
LIBERTY MOTOR
VANILLA and STRAWBERRY ICE CREAM in BRICK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on any subject. This being a S. A. E. dinner, I will, however, tell you a brief story which seems applicable to the present situation.

"I have just been down on Long Island, where we are flying a certain number of D. H.-4 machines in coast patrol work—looking out for possible German submarines. There I heard a friend of mine, an exceedingly good pilot, instructing some of the young men who were flying the D. H.-4 machines. He said: 'You men have been flying a short time, four or five hundred hours perhaps, and you probably think you can fly a D. H.-4. Let me tell you, these slow boats that make 90 miles per hour are quite a different thing. With the D. H.-4 you pull back on the stick and the machine shoots you up into the elements.'

"I have the impression, from what I have seen here, that quite a number of D. H.-4 machines will shoot up into the elements before long."

General Kenly
(C) *Harris & Ewing*

Colonel Deeds' Address

"After you have been in Washington about a year and have been investigated seven times, you don't shy at anything. My status is rather a peculiar one. You read once in a while in the newspapers something about a detachment of soldiers in no man's land. I think there are two or three colonels that I know of that represent that little saying about as well as anything I know. Colonel Waldron isn't with me tonight. I don't know what has become of one-third of General Gregory's army.

Messrs. Costello, Hanch and Caldwell

"I must follow tonight General Kenly's good example and not talk too much, but it is an inspiration to meet with you men here tonight.

"Washington is a great place. It is a great experience for a civilian to go there. Colonel Waldron and I were very much like that disc which you have seen down at Coney Island. If you stay in the middle, where you don't do much, it is pretty good, but if you get out where things are doing it isn't very long until you find yourself sliding off in a very undignified and ungraceful manner onto the sidelines.

"But some things have been done. Mr. Coffin has told us of of some of the things that have been done. One very satisfactory thing to me is the fact that a Liberty engine does not read the newspapers. But it will be able to answer for itself in performance, and this may perhaps help some of us.

"The war won't end this year, and there are bigger, better things coming to this country as the result of this great conflict.

"If any of you have ever had come into your homes some great sorrow, some dear one taken away you find a new something has come there, something for the deepening of character, something that seems to give life a very different view from what you had before. I believe in our national life that the coming of these casualty lists is going to bring us a deepening of national character, something of regard for others, something of unselfishness, and something of that which makes for greater things.

"Things are moving. This great airplane industry is just in its infancy. I wrote Colonel Arnold a little card and asked how many miles were flown each day in our aviation training schools, and he sent back the memorandum, 'Over 220,000 miles each day.'"

Colonel Deeds

Mr. Diffin's Address

"The first thing that impressed every one of us on our arrival at England was the whole-hearted hospitality that was extended to us on every hand. We had the whole-hearted cooperation of every man that we met, and we met scores and scores of them in every branch of the work that we undertook, and it was wonderfully intelligent co-operation. We went over to show them something, but I think we came back learning a great deal from the tremendous work that we saw in England and France along the line of aeronautics.

S. S. Bradley and B. L. Williams

"I am going to take the opportunity of a minute to outline to you the biggest impression that I got abroad. I feel that in this country we have woefully misunderstood the strength of Germany. I don't think that that strength is properly appreciated, what strength has been and what it is today. I think it is absolutely criminally foolish to expect an early close to this war, to expect that Germany could be starved into submission, to expect for one minute that the internal resources of Germany are anywhere near exhausted. It was evidenced on every hand by everything we saw over there what the tremendous offensive power of that country with her Allies is.

"It is ridiculous to anticipate internal revolution in Germany, as long as the Kaiser commands at least 6,000,000 bayonets. It is foreign to the education, to the upbringing of a German to in any way disregard authority. The most amazing thing that I saw was a German prison camp. Around it were a few strands of barbed wire. A boy could have crawled out of it. In there were several hundred German prisoners. I inquired why that wasn't barricaded. 'Why,' they said, 'the German common soldier respects authority, be that authority what it may. The French officers have told the German soldier where the deadline is and they don't go over it.' The German officer is another story. They hold him in with 16-foot barricades with highly charged wire around the top of it.

Elmer Sperry

"The next thing that we have appreciated there is the offensive power of Germany in the air. We have all of us read and read a great deal about superiority in the air. There is no question about the superiority of our personnel, but Germany spent years before this war started, in anticipation of an air war, and those years of anticipation were years of preparation. England and France today are getting pretty close to the limit of their productive capacity in the way of aircraft. We have got to supplant that capacity and bring what has been the newspaper dreams of the past into reality. One, two, five or ten thousand machines will not win this war for our Allies and ourselves; it will not win it for Germany. The side that puts the greatest number of aircraft in the air the quickest is the side that will win.

"Another conclusion that I reached over there was that on land it is going to be very largely a deadlock. They may win a few miles, they may lose a few. If we start driving them the other way, it is a long way to Berlin. But we can reach it in a few hours by air, or any part between there, if we only have the quantity.

"The greatest help toward getting that quantity of airplanes is the education of the people in the United States to aeronautics.

"The biggest number of people in the country today don't know that an airplane is good for anything except a county fair stunt. Lots of those people are in Washington and every other city. The biggest help that every man in the S. A. E. can be is to go home believing fully in the doctrine that airplanes will not only help win the war, but will win it, and preach everything that he has seen in Dayton as applied to aeronautics, the wonderful possibilities, the offensive and defensive power that is in the airplane. The S. A. E. membership has got to preach that to every one that they know, every one that they see, all their friends, all their newspapers, and last but not least, their Congressmen and Senators.

"When that doctrine has spread, and not until then, will airplane production reach what I believe is a necessity, and that necessity is not a few thousand planes, but countless thousands. It is up to other departments of the Government to develop the personnel necessary to fly these machines. I don't think it is out of the way to estimate that if this war lasts three years more, our fleets of machines will be in the tens of thousands. It must be if we are going to win. Germany is certainly making preparations to reach those figures."

Dr. Stratton's Speech

"It has been my good fortune to follow somewhat closely the development of the whole aviation program.

"As I look back over that program and see how you people got together and picked out a few things and stuck to them, any one knows, and it is no use for me to tell you that that is necessary for production in large quantities. Even some of our friends across the water have not learned that lesson, but it was absolutely necessary first to pick the industry that could do the job and then to settle upon the few good things that could be done.

"Now, then, after these few good things had been selected, it was absolutely necessary to meet a great many new conditions. I remember a short time ago reading a report by the British war cabinet, undoubtedly prepared as the result of an investigation similar to that of which we have heard this evening, and almost in the opening paragraph the statement was made that no engine after it was designed, after the model was settled upon and given, could be put in production under a year.

"Now, then, we have seen these people put these things into production in six or eight months in a few months, and it would have been absolutely impossible without first selecting the men who are accustomed to that sort of thing, who knew what American methods of manufacture were and without the backing of the members of the automobile industry that pulled it together and made this thing possible.

"There is another side to this thing that I would impress upon you. A great many people forget the fact that our Government is a a government by the people. We hear a great many criticisms of Congress, and we hear the members abused from time to time, but there is one thing that I always remember, and that is, that the members of Congress are exactly what you make them. They are the people that you send there, and if you don't like them, send others.

Naval Constructor Coburn, Naval Constructor Westervelt, Lieut. Breeze and Major Wadsworth

"I want to tell you that it has been the organization of the disgruntled people, those who have had the good things that have not been accepted by the Government, that have been camping around Washington day and night and getting under the shelter of the capitol, telling all of these sorrowful tales about how their good things have not been accepted, etc. That has created the impression over there, whereas you people have been producing goods, and sooner or later, as some one has said here this evening, the Liberty engine will speak for itself. But it is a fact that those gentlemen do not know what is going on, and the unfortunate thing is that they will not go to the right people to find out.

"I have said many times in Washington to people in high places that they ought to go to the right places to find out what is going on and not to these disgruntled persons. I brought Secretary Redfield to Dayton, and he was perfectly amazed at the development he saw here. He has been telling about it ever since.

"It is a good plan for every one to see that his representative in Congress is posted. I don't care whether it is engines or matters of government. That is what they are there for, and those of you who know the truth of this story ought not to hesitate one moment to tell it to those in authority."

Kettering's Closing Address

B. B. Bachman

The closing address of the evening was given by President Kettering. One of the thoughts he left was that it is the duty of the United States to settle down to some fundamental lines of making a few things and then making them in large quantities. He said in part:

"Now, gentlemen, I just want to say one word in closing. We have to do a few things, and one of them is to get the information which has been mentioned here at this table tonight out to the people at large. We have two great assets in this country—one our natural resources and the other our manufacturing ability to reproduce in tremendous quantities interchangeable stuff, and if we are to give to this country the full measure of our ability, the full measure of our manufacturing power, we have to get it firmly before the people in authority at Washington, or wherever they be, that we have to settle down to some fundamental lines of making a few things and making them in tremendous quantities. If we do not do that we are going to waste time; we are going to have more investigations, and we are going to have a lot of trouble, and in the meantime the Hun is going to keep on 'Hunning.'

"The thing for us to do is to get together, to get propaganda, if you want to call it that, to get people to understand what the real manufacturing problems are. I do not believe that anybody has the slightest conception of the tremendous amount of preparation that is necessary to produce a Liberty motor or an interchangeable airplane, and until they do get that into their minds they will never quit talking about 'we oughtn't to make this, but we ought to make that.' What is the difference—we had better have a tremendous quantity of good stuff rather than none of the ideal.

"There isn't an automobile manufacturer here that has had anything to do with the motor business but what kept on selling his this year's model, even though he had a better one for next year. We have to keep on making the things that we are making, and if there is a super-Liberty motor, let's wait until we get it before we talk about making it; and if there is a super-battle plane, let's wait until we get it before we start to make it.

"But while we are waiting and while we are idealizing, let's keep our factories running, and let's keep these things that we are making going over in tremendous quantities, and maybe after all we will find out that the super thing won't super as much as we thought it did, that what we are sending over there is very good. I have seen lots of engineers make an improvement on the automobile and have more trouble with it than the one they made the year before.

"So let's just build good stuff and get it over there in tremendous quantities."

C. M. Manley

Lieut. M. Miozzi

The Menu

One of the unique features of the banquet was the quaint way in which the menu was gotten up in the form of blue print data sheets of the well known S. A. E. standard size, bound together with string. Each sheet contained a cartoon depicting some feature or function intended to interest and amuse. These menus were greatly appreciated by the members and guests who carried them home as novelties to be preserved as souvenirs with which to remember the very pleasant banquet.

Approximate Aircraft Figures

Date about June 10, 1918.

Airplanes at front bearing American insignia	378
Planes of American manufacture set up in France	50
American aviators in France	1,746
American aviators fully equipped in France	126
American observers in France	1,800
Enlisted men of air service in France	38,367
Trained aviators in U. S.	3,467
Observers and non-flying officers in U. S.	4,922
Enlisted men in air service now in U. S.	99,001
Capacity of 27 training schools in U. S.	3,500
In training at flying fields	3,394
In training at ground schools	3,393
Men passed by examining boards awaiting admission to ground schools	4,236
In advance training—pursuit, bombing or observation	1,036
In training at schools in France, England, Italy and Egypt	2,500

SCHEDULE OF ORDERS

Primary planes	5,300
Advanced training planes	2,100
Combat planes	11,000
Engines for primary planes	10,200
Engines for advanced planes	6,692
Engines for combat planes	27,300
Propellers	35,913
Balloons	1,077
Bombs	843,735
Machine Guns—	
4 to each combat machine	44,000
Spares and extras	20,000

DELIVERIES FROM AMERICAN FACTORIES

Primary planes	4,365
Advanced planes	620
Combat planes	300
Experimental planes	195
Engines for training machines	6,126
Engines for advanced machines	1,815
Engines for combat machines	1,500
Propellers	13,863
Machine guns	31,146
Balloons	125

The Aircraft Situation

While the time is past when it seemed advisable to emphasize the difficulties which have delayed the aircraft production during the past year, except as they may indicate a way of obviating these difficulties in the future, any survey of present aircraft production must refer to some extent to these difficulties.

One of the points which has perhaps escaped proper emphasis is that there has in the past been no open channel for information from headquarters. It is agreed that where a manufacturer could get into touch with headquarters, information could be secured. However, the great difficulty was to reach the responsible head. But the chances even then were that the information available would be incorrect or obsolete before it could be put into practice, on account of the fast following changes in information which were coming from abroad.

Our Allies did not at first seem to have a true appreciation of American manufacturing methods or difficulties. As a concrete example the commissions representing both our English and French allies at the beginning of our war made available to our Government all the latest information on their individual types of aircraft, and while these officers sought to closely cooperate in every way, the English and French views were in most cases divergent, and the representatives of the two governments were unable to avoid an endeavor to dispose of their respective viewpoints on the innumerable types of machines for varying purposes. The Americans had no real military aeronautic practise to start with, and were depending upon this information from abroad. It was only with the utmost difficulty and with careful sifting and weighing and frequent change in decisions that a type of combined day bombing, reconnaissance, and defensive fighting machine was decided upon. The same difficulty has applied to every other type of machine which has been considered for the American aircraft program.

Concerning the Liberty Engine

The next step is the one, now familiar, that of securing a high-powered engine which could be standardized and adapted to American machine production methods. The result is the now efficient Liberty Twelve, the designs and production of which is really a notable American contribution to the war. Colonel Vincent and Lieut. Col. Hall, who at that time were respectively connected with the Packard and Hall-Scott companies, started work on the Liberty engine in May, 1917. As a result of their efforts and the efforts of their assistants, we have now gotten into production the highest powered twelve-cylinder airplane engine in the world. Both the Packard and Lincoln Motors companies of Detroit are now producing the Liberty Twelve in quantity, large numbers of which have at the date of writing been shipped abroad.

The Nordyke and Marmon Company, of Indianapolis, and the Trego Motors Corp., of New Haven, Conn., will be in production within a few weeks. By the fall of this year production of the Liberty Twelve will have reached such proportions that a serious question of shipping facilities will be involved.

It is agreed among aeronautical men of experience that to produce a new aircraft engine which functions properly under the varying conditions of modern air fighting within a year is an exceptionally fine achievement, which criticism of the mistakes made in the matter of publicity and construction—now happily eliminated—should not be allowed to overshadow.

Colonel Vincent has stated that the Lorraine-Dietrich was the engine he had in mind as the latest foreign practise on which the then-proposed high-powered American engine should be constructed. Both he and Colonel Hall of the Hall-Scott Co. were confident that this engine, which had a bore of 5 in. and a stroke of 7 in., would be perfected and placed in production abroad. This is probably the only miscalculation which was made in the design of the Liberty Engine. The Lorraine-Dietrich has never been placed in production, as far as available information shows, although the Liberty Twelve, which is based on the Mercedes and the Lorraine-Dietrich, and the best engine practise available in this country and abroad, is now a proven success.

The contribution of the Hall-Scott and Packard companies to the construction of the Liberty engine has been definitely analyzed and published by the Government, with several supplementary items, all of which appeared in AVIATION AND AERONAUTICAL ENGINEERING.

The advertising department of the Packard company overshot the proprieties in trying to capitalize the work which Packard contributed to this engine. This should not detract from the substantial fact that Packard spent approximately $257,000 on the preliminary experimental work on the Liberty engine. The work was done in their plant rather than at the Hall-Scott plant in San Francisco, because of the great distance of the latter from sources of material, tools, and information, as well as from Washington.

The steel cylinders and interchangeable parts of the Liberty are the really big achievement.

The much-discussed 45-deg. angle was adopted by Hall and Vincent because they calculated it would lessen vibration on account of the peculiar impulses resulting from proposed cylinder engines of the vertical type and the usual angle. The criticism that the 45 deg. angle for the cylinders was adopted to facilitate the incorporation of battery ignition as opposed to magneto ignition is, upon the testimony of both Colonel Vincent and Colonel Hall, not the fact.

A recent test on twelve Liberty engines, produced by Packard and Lincoln at McCook Field, shows that these engines develop an average horsepower of 412 and demand a fuel consumption of .54 lb. per b.hp. Better results are admittedly obtained from castor oil for lubricating the Liberty, but high volatile mineral oil is accomplishing good results. The mineral oil has a tendency to choke the spark plugs in coming down from high altitudes with the engine shut off. The practise now is for the pilot to throttle the engine down instead of shutting it off, which in practise has eliminated this difficulty.

The problem of radiation for the Liberty has not yet been fully solved, although great improvements in this direction have been made in recent tests. The latest information from abroad indicates that the proper figures for radiation of the Liberty are .06 sq. ft. of radiation per hp. This ratio figures 280 sq. ft. of radiation for the 400 hp. engine, which is the present practise. The radiator manufacturers insist that the cooling of every engine is an individual problem which must be solved in practise, and in the case of the Liberty this is being so solved.

D. H. 4 and the Liberty

Very recent reports from an American officer who has just returned from the front are to the effect that our pilots, as well as the British and French officers who have flown the D. H. 4 with the Liberty engine, are very well satisfied with the performance of this plane and engine. Official information to this effect will be the final vindication of the Liberty engine. This is expected very soon, and should have the effect of finally quieting the self-seeking critics of this question.

Information which has appeared in the newspapers during the past week or so indicates that the Spad single seater fighter is returning in official favor; also that it has been decided to go back to the Liberty eight cylinder engine, which was abandoned as part of the aircraft program last October. It has also been stated that the Liberty Eight is to be substituted for the Twelve in the two place Bristol fighting machine, orders for which were placed with the Curtiss company.

These facts may be correct, but the final decision, according to first-hand information, is to be based upon the report of another American commission which has just sailed for England and France. This commission is made up of Colonel Marmon, in command at McCook Field, Dayton, Ohio, Lieut. Col. Hall, formerly of the Hall-Scott company, and recently assisting the Dayton-Wright company to get into production, and Mr. Willard of the Aeromarine Plane and Motor Co. The purpose of the visit of these gentlemen to our Allies is to gather information on the military situation so it may be applied to our own production of fighting machines of the single and two seater types, and solve the question as to whether large bombing machines should be placed in quantity production in America.

It is understood that three types of planes particularly are now desired by General Pershing, namely: one and two-seater fighting (or combat) machines, and a twin engined airplane, lightly armored on the underside for contact patrol and ground assault work.

On the face of things, it would seem that there is now in Washington sufficient information upon which to base a decision upon all the points mentioned. It would also seem to be the most practical proposition to proceed to give definite "go ahead" orders upon the machines in regard to which there has been so much discussion. Mr. Kettering, the President of the S. A. E., struck the proper note when he said in his address at Dayton that a large enough number of 90 per cent machines would make good our part in the war, rather than seeking to secure perfection which will continue to involve serious delays.

It is interesting to note that the group known before the war as the "smaller" aircraft manufacturers, and who made up the greater part of the aircraft industry as it then existed, are now practically all in quantity production, while some of the large companies in other lines who were given contracts because of their great manufacturing capacity are not yet in production.

For almost six months after the entry of the United States into the war, only two of the companies who composed the ante-bellum aeronautical industry received any Government orders. The official reason for this was that their facilities were small and they had no knowledge of quantity production, and it would take too long to develop their resources in connection with a program the essence of which was speed.

The encouragement which the smaller companies have finally received has almost exclusively been forthcoming from the Navy. Nearly every other manufacturer in other lines who was able to convince the officials of his ability to manufacture some product in quantity was given orders by the Army before the older aircraft manufacturers secured any business. The Navy found that the Army had practically preempted the newer aircraft manufacturing resources of the country. As a last resort, and with a good deal of trepidation in official quarters, orders were placed by the Navy with the older part of the aircraft industry.

It is gratifying to a publication whose interest in aeronautics antedates April 6, 1917, to see the old aeronautical industry gradually coming into its own. The ideas of the older aeronautical engineers are daily being vindicated. The aircraft program has swung around an enormous circle, and types of machines which were advocated by practical aeronautical men before and immediately after our entry into the war are now to be placed in quantity production. The "smaller manufacturers" have made good. Had they been given proper encouragement from the start there would be less reason to criticize tardy production today.

That the airplane manufacturers are actively getting ready for real production is indicated by the following summaries of several factories compiled from reports current in aeronautical circles:

Curtiss Aeroplane and Motor Corp.

While the production of training planes (estimated in excess of 3000) during the last year at the plant of the Curtiss Aeroplane and Motor Corp., Buffalo, N. Y., has been wholly satisfactory, there has been much disappointment in the output of British battleplanes also ordered from the Curtiss plant. Fewer than twenty-five thus far have been turned out.

Of course there must have been a reason for the delay because it is a matter of no manufacturing consequence to the Curtiss Corporation whether it produces battleplanes or training planes. That it has made the latter type in large numbers is conclusive evidence that it is capable of quantity production, and, as the difference in workmanship between the two kinds of plane is immaterial, it is necessary to look elsewhere for an explanation of the slow movement in Bristols.

One correspondent writing from Buffalo recently said:

"They were ordered to build Bristol battleplanes here, and the simple truth is that only a week or so ago was the word to 'go ahead' received from the Signal Corps. So the production of battleplanes is very small—less than a dozen. How much this is due to a feeling in Washington, based upon word from the other side of the ocean that the Bristol plane is out of date, and how much it is due to a concentration on the De Haviland plane, which is admittedly a better fighting type and being turned out in quantities at Dayton, one cannot easily determine. But the order to go ahead indicates that several hundred Bristols are wanted anyway, and the Curtiss plant is in a position to construct them rapidly."

After mentioning the difficulty in obtaining decisions from the designing engineers the same writer continues:

"But the achievement of the Curtiss plant is not merely its large output of training planes—for America has a comfortable surplus now—but its work on hydroplanes with pontoons attached and the new style flying boats for the navy. The Curtiss Company has built a number of these for Great Britain and is turning them out by the scores for our own Navy.

"But the flying boat needs a fighting plane to protect it, and whichever way one turns the need of serviceable fighting craft appears essential, though in the waters surrounding Great Britain, where the hunt for submarines is carried on, it is to be presumed that the British are supplying defence machines to protect the flying boats as they locate the undersea boats and drop their depth bombs.

"These navy craft are all equipped with Liberty motors, which are working well, too. So again one discovers advantages of versatility in that much abused but nevertheless effective standardized motor.

"But a big plant like this cannot keep its organization together and all its working units intact on the small amount of work the navy will have, or merely on training planes, if a plethora in that type is being reached. It can be readily seen why so much confusion as to who is right or wrong in the whole aircraft business exists when things which I am about to describe happen.

"Last October drawings were ready for the immediate manufacture of the 'Spad,' or one-seated fighting scout. The month of November was wasted trying to make the Liberty motor fit this particular type, and finally another motor was being tried out when word came to stop building Spads. That word came from Gen. Pershing, and it never has been explained whether he was confident he could get all the scouts he wanted from the French, or he began to see that the scout was not going to be of much further use as a fighter. Anyway, the Curtiss people were told to build Bristol two-seated fighters, and had some trouble with the drawings. Finally, in January, they started to make twenty-five Bristols, but it was decided in Washington that bomb-dropping devices, oxygen tank, heating instruments, flare lights, and other things be added to the equipment. The twenty-five were held up throughout March and April, and the 'go ahead' received early in the present month. The general impression seems to be that the Government is trying to make the Bristol do things it cannot do, and that the orders for this type will not be repeated.

"Now imagine an organization of several thousand men gotten together and specially trained, and then have changes —perfectly necessary, perhaps, and inevitable—coming along to delay and disrupt the best laid of plans. It takes a long time to get drawings ready and models made after they are once decided upon, and unless on finishing one order the working force is ready to start in with the next order, employees cannot be kept. They will not be impressed or held if 'gaps' occur in production.

"The Government must keep an eye on the working force, especially when it is considered how much time and money is invested indirectly by the Government in training these employees.

"Congress and the people generally have no doubt been given the impression that much money has been spent. As a matter of fact, less than two hundred millions has actually been disbursed out of appropriations and authorizations many times that sum."

Continuing and reverting to the delay in turning out the Bristol type the writer says:

"They haven't been built apparently because Washington didn't want Bristol machines in a hurry, or possibly not at all. But the request for Bristols now has been renewed. Has any one planned what is to be built thereafter? The designs ought to be here now, but they are not. Success in airplane building will come to the nation that looks ahead and plans ahead and keeps its organizations of workmen and trained mechanics intact. The Curtiss plant has produced the bulk of the training planes and has done practically all the work for the United

States Navy—a splendid job on the whole—but the crying need is for battleplanes, and it is unfortunate that De Haviland planes, such as are being produced so rapidly at Dayton, were not ordered built here, or a Handley Page, or some other foreign type that is doing effective work."

The Glenn L. Martin Co.

One of the pioneer American aircraft builders who has obtained an important share of the Army aircraft program is Glenn L. Martin, formerly of the Martin Aircraft Co., of Los Angeles, and the Wright-Martin Corporation, of New Brunswick, N. J. Mr. Martin's plant, known as the Glenn L. Martin Co., is located at Cleveland, Ohio. The machines on which the company is working are large bombing planes of original all-American design, which are to be powered with two twelve-cylinder Liberty engines. The new plant at Cleveland was especially designed for the construction of large planes. It is a permanent plant of steel and hollow tile construction, 300 ft. wide by 220 ft. deep, with a mezzanine floor containing 2000 sq. ft., and a total usable area of 68,000 sq. ft. Specially designed folding doors enclose the entire width and height of the rear of the plant. The doors are so constructed that they telescope in each direction from the center line, so that the entire back of the building can be thrown open. Plans are completed for a 500 x 300 ft. addition to the factory. The company also owns 68 acres of land immediately adjoining the plant, which with very little grading will make an exceptionally level flying field.

Main Floor of the Main Building, Glenn L. Martin Co.

Same as Above, with the Sliding Doors Shut

The Martin organization includes Glenn L. Martin, Donald W. Douglas, Chief Aeronautical Engineer, George B. Fuller, Assistant Aeronautical Engineer, Lawrence D. Bell, Experimental Manager. These men are the active directing heads of design, experimentation, and production. Mr. Fuller was for three years with the Government in the capacity of an aeronautical engineer. Mr. Bell was superintendent of the old Martin Aircraft Company of Los Angeles for seven years.

Dayton-Wright Airplane Co.

The first company to get into production with American-built combat machines is the Dayton-Wright Company, of Dayton, Ohio, which is now shipping an increasingly large output of De Haviland 4 machines each week. These planes go out fully equipped with all military and aeronautical instruments and accessories.

During the week ended June 15 the Dayton-Wright company shipped 82 complete De Haviland 4's, the rate of production varying from twelve to fifteen machines per day. Over 90 De Haviland 4's were shipped from this plant during the week ended June 22, and at the time of writing (June 29) the company had shipped over 300 of these planes to France, 50 of which had been set up at the front.

The production of these machines has increased materially each week for the past eight weeks, and unless unlooked for conditions prevent it will without doubt shortly go to thirty complete planes per day. At first the practice was to make a complete factory flying test of each machine for one hour at an altitude of 10,000 ft. The company is now making this flying test on every sixth machine. They are flown at Wright Field, the company's private flying field adjoining the factory, with complete military load, except bombs.

The company's factory at Moraine City is now practically an enormous assembling plant. Three neighboring plants supply the larger wood and metal parts, while approximately 40 direct sub-contractors are furnishing the other parts for the machines. The woodworking shop at the Moraine City plant is now in course of removal to a new building adjoining the main plant, which will give considerable additional space for assembling the machines.

The Dayton-Wright company has been laboring under the same difficulties as other manufacturers in regard to securing information, receiving an amazing number of changes, and awaiting final instructions to go ahead. The first De Haviland 4 was completed and flown last October, and had it been possible to decide definitely to go ahead with a lot of De Havilands without change, their present output would have been probably thrice the number of machines which have been produced to date. Production now is, however, going through at a splendid rate, and it will soon be a question of adequate shipping space for the planes rather than of weekly plane production, from this plant.

Dayton Metal Products Co.

The main source of supply for tie rods and turnbuckles for the De Haviland combat planes, which are being constructed in various plants in this country, is the Dayton Metal Products Co., of Dayton, Ohio. This company has 2300 employes on its payroll, 500 of whom are girls, and has a maximum production of 25,000 De Haviland 4 turnbuckles and 6000 tie rods per day. There are 120 tie rods and 80 turnbuckles to this plane. Albert B. Hilton, Jr., is the active manager of this plant, which, in addition to the airplane work, is producing large quantities of ordnance material. The company has had the common difficulty in maintaining its skilled men on account of war conditions. To overcome this, in a measure, they are running a school fully equipped with automatic screw machinery in training men for their special work. Every effort is made to make the working conditions at this plant satisfactory to the employes. One of the features of this phase of effort is a completely equipped Red Cross department where minor or major injuries can be properly cared for by skilled doctors and attendants. One unusual phase of the Red Cross Department is the dentist's office. Mr. Hilton believes that a contended workman is not one whose teeth are in a poor condition.

The D. M. P. Company is working day and night shifts. The night shift comprises about one-third of the day force. Another interesting detail is a desire to assist its employes through the employment of an "employes' attorney." This functionary will exert his best legal offices to assist employes who have ordinary outside legal work, from the collection of just debts to securing the adjustment of matrimonial difficulties.

The tool department of D. M. P. Company produces most of the special tools required for the work which calls for a tolerance of .002 of an inch.

Aeromarine Plane and Motor Co.

The Aeromarine Plane and Motor Co., of Keyport, N. J., is one of the concerns which was known prior to the war as a "smaller" company. Since then, however, the company has grown to considerable proportions. The claim is made for this company that for its number of employes it is producing more complete machines than any other American concern. This is based upon a ratio of 100 men per machine per week. Their production is now approximately twelve Navy machines every seven days, which gives a total of twelve hundred employes for this company. The company is fabricating all the parts for the Navy machines, with the exception of propellers, turnbuckles, wire, and radiators. Nine complete machines were shipped from the factory during the week ended June 22. With each four machines one set of spares is completed, consisting of one and one-half pontoons to a machine, and enough wire, turnbuckles, cloth, ribs, etc., for two additional machines. In other words, the figure twelve represents nine complete machines and three sets of spares.

During the week ended June 29 the company produced ten complete machines and three sets of spares. The ratio of complete machines to spares can be stated in still another way. A complete machine equals 79 labor hours; a complete set of spares equals 82 labor hours. Up until June 26 the company had produced 50 complete Navy seaplanes in addition to spares. Their force engaged in productive airplane labor numbers between 800 and 900.

The usable manufacturing area of the Aeromarine Company's boat shop, panel room, dope room, and metal shop has been recently doubled, and in three months' time the company will be able to turn out from five to six water or land machines per day.

Lewis & Vought Corp.

One of the finest pieces of American airplane design and workmanship is found in the advanced training two-seater biplane constructed by Chance M. Vought, of the Lewis & Vought Corp., of Long Island City, N. Y. This machine has successfully passed its official tests at McCook Field, Dayton, Ohio. Its power plant is a 150 hp. Hispano-Suiza engine. The Vought machine is said to be the fastest machine for its horsepower of which there is any record. A very successful effort to streamline all external fittings has been made in this machine. The main plane fittings are all countersunk and covered over so that they offer no air resistance. The covering for these fittings is a small section of isinglass, making it possible to note the condition of the connections at any time. It is understood on good authority that the Vought biplane will be put into production on a large scale for an advanced training machine. Its high and low speed range is very satisfactory, landings which were witnessed by the writer being notable for the way the plane alighted. The start of several flights at the same time showed that these machines are able to get off the ground after a very short run, and climb at a rate which shows an ability in this respect in excess of some higher-powered foreign planes of similar wing area.

The Burgess Co.

Aircraft investigations at Washington developed the fact that production of Naval aircraft had progressed proportionately very much better than the Army. The Burgess Co. of Marblehead, Mass., has played an important part in the production of Naval aircraft. This company is now employing 1000 people, and is reported upon good authority to have turned out seventy training seaplanes for the Navy during June. The company is actually exceeding the Government's production anticipations, and they are making deliveries well within the periods contracted for. This company's contracts on their present schedule will be completed in the near future. Like many other companies, they are handicapped in not having large enough continuing orders to plan ahead. The organization at Marblehead, in charge of Frank Russell, is one that has done excellent work in the development of seaplanes along scientific lines. This organization is now devoting its entire energies to quantity production, which necessitates laying aside the designing of experimental planes, and this suggests a point which apparently is being overlooked in the talk about quantity production. The companies should have sufficient continuing orders to keep their organizations going at full capacity, but it would be for the best interests of the Government if when such orders were placed the airplane engineers should be encouraged to parallel production efforts with original design for future requirements.

Curtiss Engineering Corp.

To develop the airplane along scientific lines through experimentation based upon knowledge of military and commercial requirements is the purpose of the Curtiss Engineering Corp., of Garden City, L. I. The permanent concrete and steel buildings which the company has erected are divided into research and engineering departments, a complete reference library on the airplane and the patents affecting its advancement, a wind tunnel, and complete testing apparatus.

It is not the intention to handle production work at this plant after the war. Its entire facilities will be devoted to development work for the Curtiss company at Buffalo and for any other individuals or companies who may wish to make use of its facilities.

The company is at present doing production work for the Navy. The type which they now have in production at Garden City is a large Naval bombing flying boat, powered with two Liberty twelve-cylinder engines.

The L. W. F. Engineering Corp.

With a plant quadrupled in capacity to that required before our entry in the war, the L. W. F. Engineering Corporation of College Point, L. I., is now in production on Navy flying boats. These are large machines with one Liberty motor, equal to probably three training seaplanes. Production at this plant has reached figures satisfactory to the Navy.

The L. W. F. Corp. has been doing upon their own initiative some very interesting experimental designing on a fighting plane for the Army which embodies certain surprising and original features. One of these new models has undergone successful preliminary tests.

Fisher Body Corp.

One of the largest sources of production for day bombing machines is the Fisher Body Corporation of Detroit, Mich., which first began constructing airplanes on receiving an order for five hundred Standard J's. These machines, it is understood, were all completed prior to the close of 1917.

The company for some time has been working on the De Haviland 4's. It has more than doubled its productive airplane facilities, and is now in production on the De Haviland machine. About the middle of June the company had completed its first hundred DH-4's, according to reports. Stocks of parts are well ahead and when the company reaches its productive capacity the large bombing machine will be turned out probably at the rate of forty per day.

Government Test for Lanzius Airplanes

The Lanzius Aircraft Company recently shipped for official test three of their all-steel single-seater airplanes built on the variable angle of incidence principle.

Four of these machines were fabricated in six weeks under a conditional Government contract calling for a high and low speed with military load considerably beyond the range of any of the fast planes now on the fighting front.

These planes, in addition to the variable-angle principle, will be equipped with variable-pitch all-metal propellers. The principle of this variable pitch propeller has been successfully applied in the metal air screws which are now being manufactured in quantity to drive the radio sets on American combat machines.

A variable-angle machine is recognized as marking a great advance in plane construction. Paul Schmidt's machine was not a success because the shifting of the angle caused a shifting in the center of pressure. This has been avoided in the Lanzius machine by the original cantilever construction, with the axis in the center of the planes, which are controlled by a lever attached to a worm gear in the cockpit. The planes can be shifted with no more effort than involved in changing the gears in an automobile.

The first model of the Lanzius machine to be tested under Government auspices was flown at Langley Field about three months ago. It was a smaller machine powered with a 210 hp. 8-cylinder Sturtevant engine.

The principle of the machine was thoroughly demonstrated during this test and as a result the Lanzius Company were ordered to build four larger machines.

Washington Views on Production

For several weeks two separate investigations into distinct phases of the aircraft situation have been conducted. They are still in progress. One outside of Congress is to determine whether, as alleged, there have been irregularities or criminal delinquencies, and one by Congress is making an inquiry into production.

The latter conducted by a sub-committee of the great Committee on Military Affairs of the Senate with Senator Thomas as chairman, has spent practically all the time since its appointment in personal inspections of and inquiries at eastern airplane plants for the purpose of securing data preliminary to the continuance of the inquiry with witnesses at Washington.

Until this inquiry shall have been completed and the committee's report submitted to the Senate no specific statement of the committee's possible findings will be made, but it has been permitted to become known in advance in a general and unofficial way that conditions have been found unsatisfactory.

This, if true, is regrettable, for it would seem to mean that much the same condition exists now as for months past had been found fault with both in and out of Congress, which led to the investigation of the whole program last winter, and which in turn eventually resulted in the recommendations that were one of the chief factors in bringing about the upheaval and reorganization which are now historical. In this connection there is, however, one hopeful sign, for while individual members of the committee are quoted as saying that present conditions are not satisfactory, they add that the point has been reached where production in quantity may soon be expected. That is better.

An interpretation of this comment is that the Bureau of Aircraft Production is not following beaten paths, but rather that under new management the program is rapidly progressing and that though the line of demarcation between production and quantity production has not yet been reached, it not only soon will be, but will also be passed. The whole effort of the Bureau is concentrated to this end. Its attitude toward the public is diametrically opposite to what their experience may have led them to expect. Semi-officially, it may be stated that the policy is and will be one of performance and not of promise and that there will be no official publicity, at least until production has reached a satisfactory stage and shipments have actually been made. A chart of accomplishment will then be hung on the wall as it were, that all who run may read, and reading, realize that while promise is often pleasing and exhilarating, performance is the better and stronger means to a desired end.

If it ever existed, the time has now passed when the American people can be camouflaged with roseate promises that the fabled pot of gold lies just at the foot of the rainbow. What they want are results. They expect, are entitled to, should have, and will be satisfied with nothing else. If the above version of the purpose of the production division is correct, this is just what they will get—nothing less.

Commenting upon this and other phases of the subject, Hon. F. H. Dent, Jr., chairman of the Committee on Military Affairs of the United States House of Representatives, in a statement expressly prepared on June 24 for this journal, said:

"While I am not an expert on aviation or aeronautics, from the testimony before the Military Committee of the House, it is my humble opinion that this branch of the Army has played and will continue to play a very important function in the present conflict.

"I think it is somewhat unfortunate that rumors, finding expression in the press of the country last summer, induced the people to take too rosy a view of this branch of the service. The result was that the country finally became disappointed. As a matter of fact, while this branch of the service has not been built up as rapidly as it had been hoped, at the same time it has been by no means a failure. The information I have at this time is that production has now reached the point where the program can be successfully carried on.

"It is gratifying to know that the young men of the country were so eager to join this branch of the service that the Department had to discontinue enlistments.

"We have every reasonable expectation, however, that production is now upon its feet and it is believed that it will be a question of only a short time when this arm of our forces will be doing everything that the American people could desire."

While the Congressional debates which followed the investigation by the main Senate Military Committee developed what Senator Wadsworth might describe as a very large amount of variegated information, they also revealed facts and figures which are valuable in indicating the progress that had then been made in the air program.

These figures show that in a given week there were shipped from United States factories 110 primary training planes, nineteen advanced training planes, and seven combat planes, and also 241 primary training engines, nineteen advanced training engines, and eighty-six combat engines (Liberty 12). During each of three other weeks there were produced respectively fourteen, thirty-four, and thirty-seven bombing planes. In other words, in four weeks United States plants produced 211 primary, advanced and combat planes, while England and France are credited with a combined monthly production of approximately 5,000 planes, of which about 3,000 are manufactured by the former, and 2,000 by the latter. This production further contrasts with United States requirements at the front, which are placed at 2,500 planes per month to meet replacements, etc.

These figures also show that at the time they were compiled the United States had in France, 1,639 planes, of which 323 were combat machines, and 3,760 in this country, and that of the 13,000 machines which the United States contracted to have manufactured in France and England, the former number is all that had been delivered. It was developed that this country is manufacturing the Handley-Page, Bristol and de Haviland types of planes and that 107 de Haviland reconnaissance machines had been delivered to the United States.

Other information developed was that our single-seater pursuit planes are manufactured abroad, and that many of the machines of different kinds are made of American raw materials shipped to France and there assembled by American mechanics.

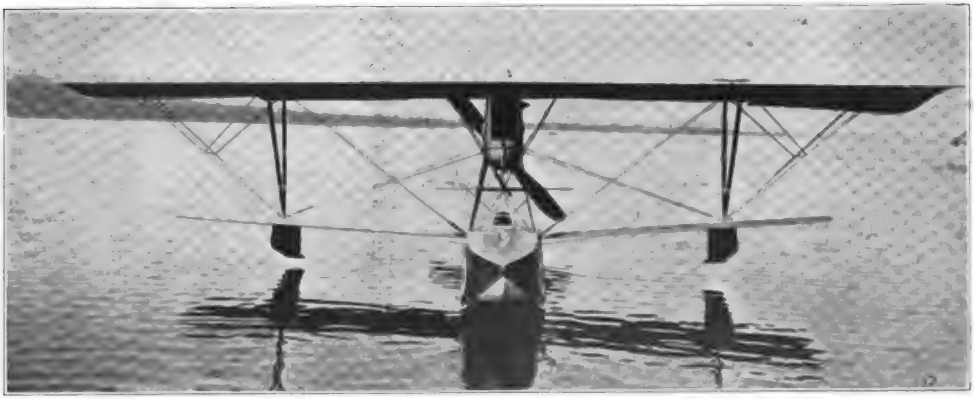
In regard to engines, a total of 1,041 Liberties had been delivered to the United States Army and Navy, of which 561 went to the former, and 480 to the latter. Both France and England placed orders for the Liberty engines and of the 3,000 ordered by Great Britain eleven had been delivered. It was also shown that the Bugatti engine is being made at the factory of the Duesenberg Motors Corp., Elizabeth, N. J.

Information developed on machine guns is that the program calls for 220,000 in addition to 76,000 contracted for: that the Browning heavy airplane gun is being produced at the rate of 1,000 per month; that 1,500 Marlin airplane guns are available and 40,000 have been ordered, and that the Browning gun, which is synchronized, is to be substituted for Marlins for airplane purposes.

In addition to the above there is information from sources supposed to be official that plans have been practically completed for the manufacture by the United States of what is said to be a type of the fastest scout machine that flies. This is a late model of a British single seater fighting biplane, the first of which appeared at the front about a year ago, and which is capable of doing every stunt known to flying. It is understood that this condition has been brought about by the inability of French and Italian manufacturers longer to turn out scout machines fast enough to meet the needs both of their own and our aviators and that if the United States is to take its proper place in assisting to acquire the mastery of the air we must undertake the work of making the light as well as heavy machines. The exact identification of this machine has not been divulged.

As to cost, the air account of expenditures shows that up to May 23 last $186,154,369 had been spent for planes, propellers and spare parts; $240,803,176 for engines and spares, and $28,496,912 for machine guns, and that the total of obligations for these and other things as of that date was $859,839,974.

From this data and other information, the deduction is that production is neither going backward, nor is it at a standstill, but on the other hand is going forward. It is gratifying to state that this condition applies alike to the Army and the Navy. Rear Admiral David W. Taylor, Chief of the Bureau of Construction of the Navy Department, who very rarely



A Study in Streamlining: Front View of an Italian Macchi Flying Boat—The Neat Engine Cowling of which is Particularly Noteworthy

Photo Western Newspaper Union

makes a statement for publication, permits himself to be quoted briefly to the effect that "the Navy's aircraft production is well in hand and shipments are proceeding with regularity."

While complaints may have been justified at the time that much valuable time had been lost in trying to develop and standardize the Liberty engine: that factories were changed over and back again for the production of different engine types; that contracts for the manufacture of the Liberty were cancelled altogether or contracts for foreign engines substituted and that all these things, due to changes in plans in France, caused delays in the progress of the air program, they are now largely annulled by tests and expert opinion that the Liberty XII is in the first rank as an airplane engine. Similar criticism, for the same reasons, was applied to airplane factories, but in view of improving, but not wholly overcome conditions these, too, must now be somewhat modified.

On the other hand, there is still much complaint, and much evidence to justify it, that some airplane plants are now either shut down entirely, or are running under capacity and that some engine factories are not being operated at anywhere near their capacity. Promises of further orders are stated not to have materialized promptly, and yet manufacturers are not allowed to fill in with private orders. None realize the hardships this works so well as the manufacturers themselves. These are only a few of the criticisms heard. What can and should be done to relieve this situation and speed up production? One remedy lies in the adoption by the Government of a code of principles such as was printed in a recent number of Aviation and Aeronautical Engineering. It is reprinted here:

1—Orders should be placed at once for a sufficient number of planes to prevent the closing of productive aircraft plants. A continuing manufacturing program should be decided upon without further delay.

2—Immediate "go-ahead" orders should be given for the completion of a definite number of machines without changes.

3—Changes and improvements, where indicated by experience or necessity, to be made in the next specific lot of machines.

4—Full advantage should be taken of the experienced engineering and production experts of the aircraft manufacturers.

5—Substitution of materials of equivalent physical characteristics and strength should be permitted, when it is impossible to live up to specifications without involving delays.

6—A direct channel for the constant flow of information from the responsible Government official to the contractors should be opened. When an order is placed the manufacturer should be immediately given all available information regarding the particular machine or machines.

7—Orders for complete machines should be placed with responsible contractors who should be held strictly responsible to the Government under their bonds for the delivery of a definite number of machines.

8—Simplification of Government cost accounting methods in the plants, so as to eliminate innumerable minor and technical disputes between Government accountants and the manufacturers which result in retardation of production.

9—Original American creative work and design should be encouraged in every way.

These essentials to production reflect a composite of the ideas of the leading manufacturers themselves. With the supply of airplane parts, such as propellers, being in abundance and with the delays in spruce production being overcome, it is suggested that the quickest way to speed up production and get fully equipped machines into the hands of our aviators at the front, in the shortest possible time is for the officials charged with this duty to adopt and follow some such plan as outlined. Speed and more speed; airplanes and more airplanes; production and more production—these are the need of the hour. These only will justify the millions and billions of dollars appropriated by Congress for the support and continuation of the whole air program. In this way only can this Government keep the faith with the Allies and warrant the confidence of the American people.

The Airplane Problem

By An Aeronautical Engineer

Much has been written about the aircraft situation and its personnel both past and present. The industry has been the mark of investigators and the investigation of investigators, and now, at last, we seem to be safely started on the right path to production.

It is not the purpose of this article to criticize the administration's policy, nor is any criticism which is not constructive of any permanent benefit. It is not the intention, either, to give a detailed account of the status of aircraft production today. To do so might entail the divulging of confidential information, tending to give aid and comfort to the enemy. I shall do my best, however, to state briefly, and in a non-technical manner, some of the many difficulties attendant on quality production of aircraft.

The problem of the airplane is highly complex: many factors contribute to make it difficult of analysis. Perhaps for a full understanding of the situation which confronted our country on the declaration of war, one cannot do better than give a brief history of pre-war aeronautical engineering.

When the Wright Brothers on December 17, 1903, at Kitty

Hawk, N. C., proved for all time that the flight of heavier-than-air machines was not a possibility but an actuality, they not only introduced us to a new era of locomotion, but also to an almost virgin field of engineering. To the end that they might not be robbed of the fruits of their labor, their methods were shrouded in mystery. The aeronautical world has not yet cast off this mantle of the unnatural.

The above statements have been made because they have an indirect bearing on the questions of the present day. Even now, aviation is viewed with great fear by a large number of people who believe there is something uncanny and weird in connection with the conquest of the air. Engineers fail to consider aeronautics as a science because it does not fall under the definition of being classified knowledge.

A collapse of the wings of a machine in air is not due to faulty design alone, but to disregard of fundamental principles of mechanics which are unalterable. They apply as surely to an airplane as to a bridge. There is nothing new in the idea of an airplane structurally: the forces to which it is subjected are now quite well understood and the calculation of the stress in component parts becomes a mere question of the application of the rules of elementary mechanics. A stress diagram, based on reasonable assumptions, is quite a correct diagnosis of an airplane structure. The more or less "cut and try" methods of the Wrights have come down to some extent to the present day. There have been no wonderful radical changes in the machine as a whole, merely refinements suggested by practical experience and wind channel experimentation.

For the airplane as an efficient means of transportation, the old Wright Model B has never been improved upon; all gains in speed have been made at the expense of sacrifice of power. The question of speed, by the way, is the airplane's one chance of ultimate utilization, since as a conveyor, it can never hope to rival other means of transportation from an economic point of view.

From the Wrights' painstaking method of experimentation, the airplane passed into the hands of crack bicycle riders and daredevil performers who hailed the invention as a new vehicle with which to thrill a blasé public. Many of the trick manoeuvers of these aerial acrobats, such as looping the loop, and spiral dives have now become part of every cadet's flying curriculum, and proved just what a machine was capable of withstanding when in competent hands.

At this early period before the more recent exacting calculation and inspecting of machines, this "stunting" led to many serious accidents; we were more prone to congratulate the flyers on their nerve than to feel increasing confidence in the safety of flight. Endeavors were made to promote the advancement of the art by flying tournaments and meets; but after the first effects of a new sensation had worn off, these efforts slumped for lack of financial support.

The first institution of learning of any repute to give the airplane consideration from a technical standpoint was the Massachusetts Institute of Techlonogy which built an Aerodynamical Laboratory to house a four-foot wind channel in Cambridge, Mass., in 1913. This installation was almost identical with that of the National Physical Laboratory at Teddington, England, and at that time represented the best equipment obtainable.

The above layout with the wind channel and model basin at Washington constituted this country's research laboratories at the start of the war.

Prior to the declaration of war by the Allies in 1914, there were several dull years for commercial aviation. A few factories were started to turn out machines for exhibition purposes, and finally a very few for the Signal Corps, Aviation Section, and for the Navy.

When war was declared in Europe, aviation received its first real serious impulse since the time of the Wrights. The numerous orders placed with our few existing airplane plants by foreign nations were the cause of great expansion, and of the installation of scientific methods of efficiency and standardization. Probably one of the disagreeable effects of war orders was the introduction into the industry of many crafty financiers who thought to line their pockets at the expense of the Allies and employed engineers of doubtful knowledge to supervise the work from an engineering end. The engineers who worked for such companies gathered together more or less valuable information on weights and performances for their own personal use, as they migrated from factory to factory.

Such small information as there was, never found its way into book form. Indeed, an engineer's value to a company seemed to rest more on his reputation as a kleptomaniac than on his value as an aeronautical expert. Whether the machines they designed would fly or not was more or less of a gamble and depended more on the state of the company's exchequer than on inherent features of design. There was no clearing house of information in aeronautics as in other branches of engineering, a state of affairs which bolstered up the idea that there was not much known about aviation as a science.

Due to the complex character of fluid dynamics, there is perhaps no physical science where more empirical formulae are employed than in aeronautics. Tabulated data on aerofoils, engines, full-flight performance of machines, weights, etc., are of the utmost importance. A logical system of units should have been adhered to for the purpose of forming a rational basis for future design and facilitating the comparison of the existing types of machines.

Thus the start of the war found us wholly unequipped as regards information and personnel. The number of true aeronautical experts in this country could probably have been numbered on the fingers of one hand. We had, at the most, two large aviation companies, the establishment of which, as I have pointed out, was due to foreign relations. It was to these meagre bureaus of information that we turned and asked for quantity production of aircraft.

The failure to produce airplanes under the old régime may be found not alone in the legacy of pre-war aeronautics, but in the appointment of many self-styled aeronautical engineers, and the desire of production experts to follow a Bible of automobile rules and to adapt apocryphal automobile production methods to the airplane. Many of these gentlemen brought qualifications in truck design and motor car accessories as an additional dowry when they joined the ranks of aviation experts. Perhaps some of these interests were not as keen to help the Government as to help themselves; perhaps, with keen insight into the commercial future, they judged the airplane their legitimate prey when the automobile had ceased to be such a lucrative source of income. By many it is believed that automobile production has reached and passed its highest point in this country.

The foregoing paragraph may seem irrevelant to the subject, and may be doing the industry a grave injustice. Without a doubt, phenomenally rapid expansion played the most havoc with the hopes of an air fleet in the early period of the war. In many factories, no attempts at order were made, and the stock-room methods were a disgrace to any system of efficiency. Production was the cry. Vast quantities of material were ordered and a large number of men hired.

Probably one of the important sub-items in connection with the rapid increase was the question of the draftsmen. Most of these men had never seen a machine, and some even lacked acquaintance with a common or garden scale. Thanks to careless dimensioning of parts for the shop, the assembly of more than one machine turned out to be a "cut out puzzle"; and as was natural under the circumstances, the workmen became skeptical of the knowledge of the engineers. The factories were to produce something—what they were to produce they were by no means certain. When the men in authority were told what was wanted, they were held up by lack of official "go-ahead orders."

Between civilian and military authority chaos reigned supreme. Orders were issued and countermanded; changes were ordered when the machines were in the assembly stage. Types were accepted and abandoned on advice of Intelligence Departments. Nowhere was there a semblance of order. What the industry really suffered from was the lack of the decision which comes with one-man authority.

In the adaptation of foreign machines, the draftsmen and mechanic question again appeared. Due to the continental system of drawings and the fact that a large part of the final finishing and assembling is left to the workman on the other side, foreign drawings were an enigma to our workmen, and their translation by our draftsmen and engineers seemed only to make matters worse.

Further, we lack the old world artisan and skilled mechanic. These men have been to a large extent replaced in our industrial ranks by automatic machinery. We substituted their motion, and to a degree their skill. But a machine is devoid of creative genius. Probably the most notable example of the old way versus the new is the Hispano-Suiza motor. This motor, while in quantity production on this side, could hardly be said to be a production proposition in this country until comparatively recently. It was only after many weary months of experimentation on many parts of this motor that it became a machine and not a hand proposition.

Perhaps an even better illustration of the difficulties of trying to design and produce an article at one and the same time may be found in the Liberty engine. This engine was supposed to have incorporated all the salient features of design of all known motors. Tools were actually made for the motor while it was still on the drafting board; and when the design was changed, they had to be scrapped as useless. Many models were actually constructed, and put into production before they had a reasonable chance to demonstrate their motive ability.

This prenatal influence was a serious handicap. It has been wisely said that the reputation of the first Liberty motor was killed by kind friends who talked it to death before it had shown the first spark of self-sustaining life or uttered its first official cough. The production of the Liberty to the exclusion of all other makes of motors was a mistake; it would have shown more foresight if we had guarded against failure by the joint production of several foreign motors of demonstrative ability.

It might well be asked at this juncture: "Is the airplane a production proposition?" The rapid advance of the art causes so many changes in design that it is probable that, had it not been for the advent of war necessity, no immediate attempts would have been made to standardize parts, to say nothing of types. What are, then, the standardization limits? The limits which we cannot go beyond in quantity production without sacrificing the value and the time to be obtained by the introduction into the game of new types? This is a much mooted question. Its answer will come from "over there." Experience is the best teacher.

The aerodynamical efficiency of a machine and its fighting qualities must forever be a compromise. The answer cannot come alone from mathematical analysis or research laboratories; some of the theoretical controversial aspects of the airplane may well be left to a later day. We are at present more interested in the ability of aircraft than in their stability. In fact, excessive stability is of no great importance in a fighting machine; it may prove decidedly detrimental to its agile performance and quick response to controls. No time should be lost, however, in the standardization of bolts, nuts, lugs, wires and small fittings, as has already been done by the Society of Automotive Engineers.

The question of the relative value of analytical research and actual experimentation may well come up for discussion in view of recent developments. The French, who were in the front ranks as exponents of theoretical research in aerodynamics, and who had many well equipped laboratories prior to the war, have, if we are to believe technical gossip, abandoned most of their aeronautical laboratories within the last few months. They are reported as devoting themselves wholly to full-flight testing. Laborious calculations on the airplane structurally have been superseded by rigid sand load tests. In general, two sets of trusses are built for each experimental machine: one for sand-loading; the other for full-flight testing. It is by the employment of these more direct methods that much time is saved.

The English, on the other hand, have kept all their existing pre-war tunnels operating, and have added considerably to their equipment. The Britons still cling to their mathematical analysis of machines. But they have adopted continental usage to some extent, in the idea of sand-load tests. It is rather disheartening to have to admit that today, the French have the better machines. It is true that they do not excel their Allies by much as regards speed or climb alone, but they are a better fighting proposition than any now on the front, with the exception, perhaps, of a few Italian machines.

The establishment of postal routes and mail service via air in this country is an excellent idea. It furnishes our men with cross-country flying experience, and tests out planes and engines. It is the nucleus about which we may develop the airplane until it occupies the place in our commercial life which it merits.

It is evident, then, that we do not want to lay too much stress on analytical research lest we find ourselves as England with her R. A. F. machines at the start of the war. The paper performance of these machines was truly remarkable; but all honors in the war have gone to Sopwith, De-Havilland, Short, etc.—in other words to the practical airplane constructors, most of whom combined actual experience in the air with mechanical genius.

Lack of production in the United States may also be laid at the door of poor specifications. The percentage of material lost because of super-rigid specifications was enormous. It is obviously unwise to try to follow foreign material specification in domestic design. We have not had a chance as yet to develop some of the special alloy steels mentioned in their reports. This problem is perhaps more for the metallurgist and chemical engineer than for the designer.

There is still need of more first-class inspectors of lumber and other material, to the end that the amount rejected be brought down to a minimum, and waste may be eliminated. The establishment of a training school for army inspectors of material might remedy this defect.

It has been suggested that Army and Navy aeronautics be under one head; this chief to be termed Air Secretary, and to have a place in the cabinet. This would seem to be an excellent suggestion and prevent the duplication of equipment and give even more centralized control than exists today.

The founding of a committee or board to take care of inventions would seem to be a move in the right direction. For just as the Wrights were forced to troubadour their way through the courts of Europe extolling the merits of their invention, just so many laudable inventions are probably passed over today for lack of a real engineering court of appeal. It might be well, also, to found an engineering committee to take charge of propaganda of a technical nature. Enthusiastic and irresponsible newspaper correspondents would thus lose one of their pet diversions in writing scientific memoirs on subjects with which they are not even on speaking terms.

At the present time we seem to have removed a large number of useless parts in our production machinery, and to have reduced the friction between military and civilian authority to a minimum. We are on the highway to success.

But, now that we are on the verge of quantity production, it might be well to keep an eye on the quality of the article which we are about to turn out in such large numbers. Inspections of the right kind should not be relaxed, and advisable changes in design should be made at opportune moments.

The question as to the best method of procedure in transporting our machines over-seas is still more or less under discussion. The two methods are, (1) crating machines, and (2), transporting machines under their own power. The reader will be surprised to learn that the airplane in "knocked down" state, ready for shipment, occupies approximately twice as much room as when erected. Its shipment thus presents a serious problem in these days of limited shipping accommodations. This question is so serious, in fact, that ways and means are now under advisement to discover some plan by which the machine may itself become a vehicle of transportation. The selection of intermediatory flight stations is under consideration. The first trans-Atlantic flight seems to be only a question of a short time.

A glance at the situation today shows that much work has been done, and a great deal more remains to be tackled. The aeronautical world is alive to the issue at stake, and is anxious to expedite both the production and shipment of planes. We are eager to make good our promise, though at a later date than anticipated, with an apology for the delay in the form of overwhelming numbers of machines as a combined answer to our critics and a challenge to Autocracy.

Aeronautical Patents

GRANTED MAY 14, 1918

1,265,770—To Lloyd C. Gkisson, Atlanta, Ga. Airplane.
1,265,797—To Henry Lurz, Jersey City, N. J. Kite.
1,266,151—To Nicholas Pogolski, Washington, D. C. Airplane.
1,266,338—To Charles Frederick Smyth, New Haven, Conn. Balloon-valve.
1,266,341—To Charles E. Stitzer, Denver, Colo. Gravity-stabilizer for airplanes.
1,266,508—To Herman Ludtke, Morris, Ill. Parachute.

ISSUED MAY 21, 1918

1,266,746—To Lewis G. Young, New York, N. Y. Airplane.
1,266,888—To Paul Robert Wagner, New York, N. Y. Flying machine.
1,266,986—To Joseph Preatka, New York, N. Y. Flying-machine.

Manufacturers Make Production Suggestions

That the manufacturers, large and small, are intent on rendering all possible assistance to the Government in pushing the aircraft program to a successful termination is evidenced by the many letters printed below. These letters apparently were written with the single thought that helpful and constructive criticism will be appreciated by those who are responsible for the successful conduct of the great task of securing an adequate production of aircraft. There is an entire absence of condemnation for past mistakes—the main thought is to secure ample production for the future.

That there has been a great improvement, that production has actually commenced is certain, and before long this production is bound to be greatly increased. The period of greatest difficulty is believed to have passed, and manufacturers are taking a much more cheerful view of the situation. Of course, there are manufacturers who feel that they have not as yet been given proper consideration by the Government, believing that their facilities and experience entitle them to share in the work. Their opinion is that the plan of utilizing the smaller aeronautical plants to some extent has worked out in a most successful manner, particularly as some of these factories are ahead of schedule in Navy work.

While no opinion has been expressed on the advisability of manufacturing the four, six and eight cylinder Liberty engines, it is thought in some quarters that this is a proposition that should be carefully considered, inasmuch as their reliability, light weight and ease of production should properly fit them for uses for which the Liberty 12 is unnecessarily heavy and powerful.

It is evident that manufacturers are willing to do their utmost to assist in every way the aircraft program, but some of them strongly express the opinion that the cost plus system is undesirable, tends to decrease efficiency, creates labor discontent and is unnecessarily expensive. There is also a demand that continuing orders be placed so that factories may be kept in steady production and thus secure efficiency in quantity and cost.

The letters which follow contain many suggestions that are of value, and reflect the views and sentiments of manufacturers who are anxious to do their part in aircraft production.

John L. Alcock & Co.

We were interested in supplying Pacific Coast silver spruce and West Virginia spruce to airplane factories up to about eight months ago. The Government then commandeered all this lumber direct for the manufacturers, and as merchants our business has been completely stopped.

We felt for a time the business would be subject to the control of the Government, and that we should be able to continue our business, but later development showed that the Aircraft Board considered it necessary that all transactions should be direct with the manufacturers, and, this, of course, eliminates entirely that portion of commerce which was conducted by merchants, and which contributed so much to the development of commercial relations throughout our country, and also throughout the world.

American Bronze Corp.

Our experience with the Aircraft Board and all of its subsidiaries has been most satisfactory. We have encountered nothing but the promptest acceptances of suggestions as to tests and any recommendations we have felt justified in offering have been given the promptest consideration and action.

The inspectors who have visited our plant have been unusually capable men and were not slow in recognizing the sincerity of purpose which actuates our production. We have found every division of the Aircraft Board, with which we have come in contact, always ready and willing to thoroughly investigate any matter or suggestion we offer. While there have been some changes in the specifications, we know that these changes were made in the interests of standardization.

The only suggestion we could offer as to improving conditions and production would be to give the Aircraft Board the support to which present rate of production proves they are entitled.

E. G. ANDERSON,
Sales Manager.

American Sash and Door Co.

We are now producing 15 propellers per day, which output can be rapidly increased to 100 per day if necessary, and the Government inspectors are extended in their praise of our performance.

Unfortunately we have well under way the small order that was placed with us, and at the present time have nothing further definite in sight. We have hopes, however, that the new program will enable us to employ our organization and equipment which we have built up at so much expense at the request of the Government officials.

So far as the basis at which we are willing to manufacture propellers is concerned, will state that we have repeatedly tendered our plant or our services, or both, on any terms that might be acceptable to the Government, and this proposition still holds good and will, so long as it may be necessary.

F. J. Moss,
President.

The Cincinnati Lathe & Tool Co.

It has been our opinion for some time, that in every city or district, especially where such Government work is being done, as in Cincinnati, a practical mechanic, or one thoroughly acquainted with the work in hand should be appointed, with the proper assistance, to get the maximum production out of that particular district.

Those in authority should map ahead, all the work that is to be done during the next year or so. Then, let the manufacturers interest, take hold of it and push to the utmost.

Regarding the cost-plus contracts, believe by this time that most of us know what a bad taste it has left, especially in paying inefficient labor about 200 per cent more than their real worth.

During the past few months our facilities have not been used by the Government to the full extent, because, if absolutely necessary we could operate a night force and overtime. We here are very anxious to do our bit.

During the past fifteen years we have been devoting all of our time building Cincinnati Metal Working Engine Lathes, therefore, have the facilities and ability to produce such machines.

Dural Rubber Corp.

We feel that pioneer manufacturers of aircraft or equipment—the companies who were in business before the war and who have spent many dollars and valuable time in research should be taken into greater confidence by the Government—that is—if upon investigation they were found worthy.

Our particular field is the manufacture of rubber parts for aircraft. We have worked for several years and today are producing nineteen different parts all of which are being used by some of the largest manufacturers of aircraft.

We feel that under the present congested financial conditions the aircraft manufacturers should be instructed by the Government to give trade acceptances to sub-ontractors. I realize fully that the Government will not, directly, give trade acceptances but they are greatly in favor of their use. This seems to the writer, off hand, an opportunity to use this admirable method of finance.

So far as our company is concerned, we have received no cooperation from the Government, either in experiments or acceptance of our products. We have not applied directly for any assistance. With us, it has been a matter of presenting our claim for each article to the aircraft manufacturers, experimental department and receiving individual cooperation. We gladly welcome any Government cooperation available.

Our plant is capable of manufacturing the rubber equipment of 75,000 to 100,000 planes, depending on model and size. This figure, however, would not include outer casing or exercizor cord. Some of these parts upon which we have worked for a long time but our real production has scarcely been touched. We are anxious to increase our volume of business.

E. H. Wilson,
President.

J. A. Fay & Egan Co.

As we fitted up the original factory of the Wright Bros. at Dayton, O., many years ago, and subsequently the Glenn L. Martin factory at Los Angeles, Cal. we quite naturally were called into consultation regarding equipment for the large airplane factories established in this country since we entered the war.

Our facilities are such that we have been able to ship from stock, practically all of the machines of the type made by us, required in equipping the new Dayton-Wright factory, Dayton, O., the enlarged Curtiss factory, Sturtevant, Thomas-Morse, West Virginia Aircrafts Co., Glenn L. Martin, Wright-Martin, Standard Aircraft Corp., Gallaudet, Boeing, etc., besides the many smaller equipments required by sub-contractors on parts, the Naval Aircraft factory at Philadelphia, and its bases abroad, the U. S. Army for its repair shop and experimental fields throughout the country, and what we have done in the way of quick deliveries in the past, we are ready and willing to do again.

At the same time, by cooperating with the production engineers of these different plants, we were able to re-design some of our standard machines into semi-special types for this work, developing a machine for cutting up without springing, the long stock required for longerons and wing spars, a high production machine for making stringers and wing web caps, another for building up laminated material for wing spars, another for cutting the holes for seating the aileron hinges, etc.

Quickly realizing that there was a lot of experimental work that would have to be done in order to develop special machines for this work, we shortly after the United States entered the war, cabled our correspondents abroad, to forward data on equipment used there for this work. As a result, through a special arrangement with the British Royal Air Board, one of the foremost engineering authorities on this subject, made a special trip to this country last summer, bringing with him, complete drawings, models, and other data on this work, and stayed here at our factory until fall, assisting us in getting these special machines into production. These machines are numbered as follows: No. 444, an automatic propeller shaper; No. 445, a universal vise stand; No. 446, an automatic propeller boring machine; and No. 447, an automatic strut forming and finishing machine.

We have already manufactured and delivered to the Army, Navy, and different airplane factories, a considerable number of these different machines, and anticipating a tremendous need for these special types, as their time and labor saving advantages are realized in this country, we have brought through a large quantity of each type, so that as soon as the appropriations for the new fiscal year are available and new contracts let, we will be in position to do our part, by making immediate shipment of these special and semi-special machines, and also of our standard types.

E. C. Schwertman,
Airplane Machinery Division.

The Fulton Co.

To date we have received no contract for airplane equipment, but proper officials are testing out at this time a number of different devices which we have submitted to them, and with one or two minor exceptions. we are getting all the cooperation possible from those in charge. Since the new Aircraft Board has taken charge there has been renewed activity along certain lines, and we believe that important results will shortly be accomplished.

We have offered the service of our engineering staff and laboratory to the Government to use in any way they may deem necessary, and the officials were appreciative of the offer.

Regarding our opinion on the relative merits of the cost plus and the straight price contracts, we cannot condemn too strongly the former system, as we believe it demoralizes any organization or industry in which it is used. Our experience has been that cost plus contractors entice away the individual members of other organizations by paying exorbitant wages, as they of course make twice as much profit on a ten dollar a day man as they do on a five dollar a day man. Under the cost plus system there is very little incentive to keep the cost down, or to keep the efficiency of the work.

The writer's personal opinion as to how production can best be increased and expedited, is that the draft law should be changed to include all men to forty-five and take workmen out of non-essential industries and place them in the essential ones; use more women on light production work; do not put any restrictions on standardization or time study and efficiency work; and require every man in the country to register with the draft board when he changes employment, regardless as to whether he is within the draft age or not.

Our facilities have not been used by the Government to their full extent, for the reason that our product is a very special one, and we must hold a certain portion of our capacity for particular work we are doing for the Government, and we could not afford to take on work that other concerns could do, and thereby preclude our producing special work mentioned. We are now building additional special machinery which will enable us to handle more work. We have no complaint to make of any matters, except that with any large organization there must necessarily be a lot of "red tape," and this some times hampers operations.

Wm. P. Toms,
General Manager.

Flottorp Manufacturing Co.

We have received contracts for quite a number of propellers which were obtained on account of our former reputation and good recommendations. The inspectors as a whole, have been very reasonable and in most cases they used good judgment, but it seemed to be with the Government the same as with the manufacturers, they cannot always obtain experienced men, and for that reason it has been very much appreciated by this company that there is a traveling inspector, who has a little more authority and can adjust any matters that may not be entirely satisfactory.

We have had quite a few changes in the specifications and also in drawings, which has caused a little confusion in our factories, as it was impossible to change immediately and the inspectors insisted that the change should be made as soon as the new specifications was received, but this has been taken care of in a satisfactory way so I do not think we will experience any future trouble. We have been permitted to finish up material that had been started in accordance with old specifications and blue prints, and only had to make the change when we got our plant and material in such a shape that it was possible.

Obtaining material, acceptance of our productions, and securing financial remuneration has been very satisfactory. It is a surprise to me that the Government has been able to eliminate the red tape to the extent it has. I think everything is running fine in our line.

I believe the straight price contract has a tendency to stimulate production and lower the cost, if the contractor can get sufficient orders ahead so as not to be compelled to lay off his men, after they have been trained for particular work.

This company has facilities for increasing its production about five times, if we are assured of steady work for a considerable length of time and we would be very glad to do all in our power to get the production up to this mark.

Ole Flottorp,
President.

Kawneer Manufacturing Co.

In the rush and anxiety of war production, it is necessary that we frequently survey the situation to see just how much progress we have made.

Those not conversant with airplane construction can hardly realize the problems confronting this young industry when our country entered the war and, almost over night, called for huge production of aircraft. Our Army had few aircraft standards. Those we had, were for the most part rendered obsolete and useless by the experience of our Allies in the early months of the war.

Our problem was to adopt light gage steel to take the place of other material which was difficult to obtain and to standardize parts so production would meet the immediate requirements of the constantly growing aircraft program.

Our three metal working plants were engaged, even before our country entered the war, upon the problem of adapting metal to airplane construction and we have a pardonable pride in the success we have obtained. Our organizations are now working at top speed turning out metal parts for the larger airplane producing companies. These metal parts, which we are now furnishing as standard construction, include: rudders, elevators, vertical and horizontal stabilizers, fusilage parts, struts and braces, and trailing and leading edges.

The next few months will see some wonderful developments in aircraft production. It has taken time to work out experiments and establish standards. This field has required large creative development and constructive work. Now that these preliminary hurdles are successfully passed, the straightaway will find this industry meeting our increasing war requirements promptly.

Production on airplane parts in our plants has increased every week since we turned out the first set of parts. We expect that our production will show a large increase in the next thirty days. In a very short time we could, without doubt, more than double our present output. Our factory organization is being re-vamped as rapidly as possible to the point where we can handle an immense increase in aircraft orders. We are willing, if necessary, to place all of our facilities at the disposal of the Government.

It might be an opportune time to mention that at the same time we developed our production activities in aircraft work, we have also developed ideas in special construction, such as the "Kawneer" steel trailing edge and all steel tail construction. We are justly proud of this achievement, inasmuch as these ideas have received Government approval and have been very extensively adopted and applied, as regular construction, by the leading airplane manufacturers in this country.

Throughout the past year or more of constructive work conditions have arisen that in our opinion might have been improved. There have been what looked to us to be unnecessary delays, but perhaps that trite old saying—"Haste makes waste"—was made for just such a situation as we have been facing during the past few months. We must bear in mind that it takes time to organize and build a successful product in either a new or old plant. So when we created practically a new industry which demanded the utmost effort of a number of plants, it would have been too much to expect that the whole machinery would run smoothly from the start. It is, indeed, encouraging that we have been able to meet and overcome these problems.

F. R. Eaglesfield,
General Sales Manager.

Lawson Aircraft Corp.

During the past six months I have been furnishing to Congress a bi-monthly bulletin containing information for the different members of the House of Representatives and the United States Senate.

The principal object of these bulletins is to give to the gentlemen whom we have to depend upon for the cash with which to build airplanes for the United States Government a general understanding of the aeronautical situation.

Some of my messages to Congress during the past have been considered of sufficient importance by that body to be published in the *Congressional Record.* In some instances, however, it appeared to me that some of the members were rather skeptical as to the general outlook for the future of the aeronautical industry as I outlined it.

The different members of Congress, however, are not supposed to be specialists in the aircraft line any more than they are supposed to be specialists in any other line, and so the only way that they can acquire knowledge along any particular line in which they have not had special training is through those who are directly interested in the subject.

Congress is willing to admit today the necessity of spending a billion dollars for aircraft because other nations have already expended anywhere from $2,000,000,000 to $3,000,000,000 apiece. These nations are: France, Great Britain and Germany, each of whom has already spent from two to three, or even four, times as much money upon their air programs as the United States Government has spent upon its air program.

The day of the $1,000,000,000 air program is past, and our air program must be considerably enlarged if we expect to defeat Germany, who has already expended more than $3,000,000,000 on aeronautics.

Under date of March 15, 1918, I urged the members of both houses to consider seriously the appropriation of $10,000,000,000 to build and operate a monster air fleet with which we would not only be able to defeat the Kaiser, but also give us the only weapon that will defend this country successfully against all attacks of its enemies after this war is over.

There is no good reason for this country to continually drag behind such nations as Germany, France or Great Britain, and as all of these countries lead us at the present time in aircraft, it is about time we made up our minds that we would take the lead for a change.

So in the last analysis we will either have to condemn Congress for not having sufficient foresight to appropriate sufficiently large sums with which to build and operate great American air fleets that will defeat the Kaiser, or we will have to give Congress credit for having had foresight enough to appropriate sufficiently large sums to do the job.

There is no question but that the manufacturers of aircraft in America will be able to perform their part of the undertaking, and that the American airmen will also be able to take care of their share of the work if the men at the top are able to look after properly their part of it.

Thomas W. Lawson,
General Manager.

Michigan Aircraft Co.

We take pleasure in submitting to you our opinion on the aircraft situation, and wish to call to your attention the copy of a letter which we mailed recently to the Aircraft Board. This letter shows that we are quite familiar with the present conditions, and, having been actively engaged in the aircraft manufacturing and experimental work for nearly eight years, we are sufficiently competent to express our opinion, which we hope may be of some benefit and have appreciable effect on the success of the new aircraft program.

Looking at the vast and difficult problems the Government must solve to increase production of aircraft, we can clearly conceive how tremendous this task is and can understand that countless difficulties must be surmounted before the abnormal call for airplanes is satisfied.

We are inclined to believe that almost immediate results could be effected if small aircraft manufacturing concerns were given an opportunity to secure orders for limited numbers of machines, and that in this manner much needed aircraft manufacturing facilities could be successfully developed. A moment of intelligent thought on this important subject would show that the few large manufacturing concerns in this country were very limited in size and resources, and that their output of aircraft in pre-war times was practically negligible. Under the stimulus of war orders they developed into huge manufactories in short time, some of them employing thousands of workers.

Small aircraft concerns of today constitute the nucleus of our war aircraft industry of the immediate future, and we believe that they should be given small initial orders for aircraft, to assist them in the experimental work and coach them in their effort to win an important place in the aircraft industry, which is being forced on us in increasing proportion through the war.

The large centers of woodworking industries should be taken full advantage of. Through casual observation it appears to us that concerns engaged in furniture and piano manufacturing could produce and assemble wing ribs, frames for control surfaces and wings in great quantities, and it might be advisable to establish aircraft assembly plants, in charge of experienced personnel in each center of woodworking industry.

The new concerns unacquainted with war requirements and beginners in industrial fields should be given every atom of information in the Government's possession, so as to let them get straight on to the manufacture of aircraft in the most efficient manner. In addition they should have the privilege of entering certain aircraft factories which are known for their efficient production system, and there through actual observation gain additional experience that could be usefully applied in their own plants or factories.

To double the present aircraft manufacturing resources we must adopt part of our enormous capacity for production to aircraft work, and we can not afford to overlook any concern that shows any adaptability for aircraft work, no matter how limited its resources or how small its output.

The experimental work should be encouraged and experimental efforts of individuals or concerns should be investigated, and if found to be of merit should be sent to experimental fields designated by the Government for this purpose. With the assistance and co-operation of the Army and Navy experts, good and practical ideas could be successfully developed and valuable improvements secured.

The complicated and (to the Government) unfair cost plus system should be immediately abolished and replaced with the single straight price contract. It appears that the cost plus system if it is handled so as to be absolutely right, or as near thereto as possible, is very inefficient and expensive, and causes confusion and interminable delays. This system must be replaced with the more expedient and practical straight price contract, eliminating all the red tape and unnecessary expense.

To eliminate delays caused by inability of the contractor to secure materials required for the building of aircraft, arrangement should be made with the manufacturers of materials to have stock on hand ready for immediate shipment. The contractor should be furnished with a list of firms that are nearest to him and that will supply him with needed materials at once and at the prices stipulated by the Government. It appears that a system of this sort, or similar to it, would eliminate cross shipments and long-distance shipments.

Only by undivided, persistent and intelligent effort can the desired upbuilding of aircraft manufacturing resources be accomplished. By eliminating red tape and co-operating with the manufacturer, the output of airplanes can be materially increased.

Knowing that the final success of our efforts in the war depends upon our overwhelming ascendancy in the air, we must not neglect anything in putting forth the very best that is in us—as we would do if the enemy was hammering at our shores—to get the aircraft program under way.

We must and we will succeed this time.

Anthony Stadlman.

(Copy of Letter to Aircraft Board)

For the past twelve months and during the time when the necessity of speeding up of aircraft production was most urgent and imperative, we were offering our services as manufacturers of aircraft to the Aircraft Board, anxious to cooperate in the production of aircraft and willing to place our organization, manufacturing facilities and our long experience in airplane construction at the disposal of the government.

After numerous trips to Washington and our interviews with the officers in charge of the production division of Aircraft Board, it became quite apparent to us, that it was absolutely impossible for us to receive due consideration and recognition and no matter how loyal and sincere we were in our intentions; that we did not have the remotest chance to secure even a small order for airplanes that were and will be needed so badly for our army.

All our efforts to prove, that our long experience in the art of airplane construction and designing was a guarantee of our ability to make good in the production of airplanes and that we did not need to be educated in this new art, as some of the firms that secured large contracts for aircraft in spite of the fact that they never had any practical experience in airplane construction, or the remotest knowledge of aeronautics in general—failed, and we could not help but feel that we have been purposely slighted at a time when it was clearly apparent that the aircraft program was falling rapidly behind the schedule and when it was really imperative to take advantage of all the aircraft manufacturing resources especially those that possessed practical experience and knowledge, and could have been of potential value to the government at the present time.

We can not understand why we were not given an opportunity to assist in speeding up of aircraft production and why our manufacturing facilities even though they were comparatively small were not secured to increase the output of so much needed aerial equipment, when orders were being placed with foreign manufacturers for great numbers of machines, as disclosed in the investigation of the aircraft situation, and when the furniture manufacturing companies of this city, although they never had any practical experience in aircraft manufacturing nor the organization of experienced men to take care of this work, to start with, were given large contracts for Bristol scouts and huge and complicated Handley-Page machines.

We can realize the great difficulties which have had to be faced in building up an aircraft industry in this country, and in securing production, and we know that eventually manufacturers who were never connected in any way with aircraft production, would have to be initiated and educated for this essential work, but we maintain that the concerns with experience and ability were entitled to first consideration and that unnecessary confusions, delays and expenses that were bound to develop with inexperienced firms could have been avoided and far better results secured.

Placing orders with foreign firms for immense numbers of airplanes, while so many of small aircraft firms in this country were on the verge of closing their doors after several years of hard struggle for their existence, was another harmful blow to the development of aircraft industry in this country, and it will make it so much more difficult for us to keep up with the foreign competition after the war when the commercial future of airplane is established. Leading men of this country and foreign countries are convinced of immediate commercial future of airplanes after the war and we must try to establish our prestige in this commercial development while we have the chance to build up an aircraft industry by placing initial orders with firms that have had the necessary experience and eventually would develop into potential factors in the American industry.

The present situation and the fact that a still greater expansion in its aerial program was recently decided upon by the government prompts us to send this letter to you with hope that it will draw proper attention and secure due recognition to a number of small aircraft manufacturing companies in this country.

We wish to state that we have endeavored to keep our organization together under very adverse conditions and in spite of discouragements, and that to-day we are just as anxious to cooperate in the production of aircraft as we were a year ago. It is very essential that we know whether or not our services, which we will proudly render, could be of any value to the government.

Any information that may be required in regard to our manufacturing facilities, personnel and experience can be secured at the Office of Lieut. Lohman, Bureau of Construction and Repair, Navy Department, Washington, D. C.

MICHIGAN AIRCRAFT CO.
ANTHONY STADLMAN,

June 1, 1918

The Motometer Co., Inc.

In a letter on the aircraft production situation, it is quite evident that it will be impossible to be both diplomatic and constructive in one breath.

We believe that constructive suggestions are really what are required, and hence, we offer the following as taken from a long list of troubles which we have experienced in obtaining practical specifications, adequate instructions as to inspection, equipment, deliveries, etc.

Let us start out by saying that we have been much pleased to notice a marked lessening in the amount of red tape involved in securing and executing contracts, within the past four months, and that, we believe these improvements will continue in the right direction from now on. First, we should like to see a closer co-operation between the bodies of men who draw specifications, issue contracts and do the inspecting, located at Washington, and the men who install accessories at the factories, do the testing and conduct test flights, and the aviators themselves who have to use the product.

We feel that the men in Washington in charge of the above, do not spend enough time in the field talking to the second class of men mentioned, whose practical first-hand knowledge of which is wanted and which is so essential to efficient readjustment of already drawn specifications, or the intelligent writing of shipping orders, or a practical mode of inspection.

We suggest that it be made possible for the all too busy heads of these departments to get out into the field for the purpose of becoming more intimately acquainted with the practical conditions, so that their view of what is required by the fliers and what conditions must be fulfilled may be much broadened by the opinion of those who must actually use the product which they order. By this method, and this method only, does the manufacturer acquire an intimate knowledge of the requirements of his customers. A system of building his product along lines which do not satisfy the customers' demands or which do not operate efficiently under the conditions for which it is intended, would, in a very short time, ruin his business entirely. Let our Government apply these methods to its business of supplying the aviators with aircraft accessories.

Our second suggestion comes as a direct outgrowth of our first. We, as manufacturers, are pursuing our every day practice of following up our product by sending engineers to the fields and factories where our instruments are being installed and used, for the express purpose of ascertaining the faults which our instruments may possess, or for the purpose of at least separating the good and desirable qualities of our product from the features which are undesirable. In the course of these trips and by means of many interviews with those who use our product, we are constantly informed as to the true performance of it. We are frankly told where it can be bettered. These suggestions we endeavor to incorporate in new designs for the purpose of delivering an instrument of higher quality. This information, compiled with our many years of practical experience in our own line, we believe, puts us in a better position to judge as to just how our product should be built than is possible for any one else to know.

We have tried to hold ourselves equally receptive to suggestions from Washington as to changes "believed desirable" there, and have been only too eager to make suggested changes from no matter what source they have been given. These changes have often proved of little value later, and much valuable time has been lost by holding up production for these changes.

We, therefore, enter here a plea for more leeway to the manufacturer, in order that he may deliver his best, unhampered by the possible wording of a set of specifications which may be correct in judgment as to dimensions, weight, etc., but which dictate actual ways of manufacture, dimensions of parts, etc., which cannot be changed except through a long series of delays and arguments, which sometimes result in a negative decision. Cannot our Government place more reliance in the men who are supposed to know their particular line best?

Our third and last request is that when contracts are awarded, we believe much time can be saved by furnishing all possible instructions with them. At present, we are awarded a contract for a large number of instruments all alike in certain details, yet radically different in others. In the course of time, definite instructions, as to what quantities of which type, are forthcoming, and on account of having received the total contract some weeks before, we are expected to start deliveries on receipt of these instructions. As a matter of fact, these instructions may be absolutely necessary in order to start manufacture on this particular type.

In short, let all available data be furnished the manufacturer at the time the contract is let. This, we feel sure, will hasten deliveries.

All of the above we offer in a constructive spirit of cooperation with our Government, with the hope that it may aid in improving the situation which, we are convinced, is steadily becoming better. R. P. NICHOLS.

Mott Wheel Works

At the present time we are doing a great deal of Government work and have a large capacity open for the manufacture of airplane wheels and rims. We could without question of a doubt produce in the neighborhood of 200 complete wheels per day, as we have a large amount of material and machinery especially for handling this class of work.

Anything you can do for us in regard to securing contracts along this line will be greatly appreciated.

JAMES N. HOUSE,
Sales Manager.

Scientific Aeroplane Co.

I would like to call attention to the importance of experimental work and to the sad neglect of this at the present time, almost as much as in the past.

Germany merely improves what we originate. Her two greatest weapons—the submarine and the airplane—were the product of *our* inventive genius. There are other forms of flying machines, such as the helicopter, that are highly desirable and very much wanted, yet little or nothing has been done toward setting our inventors at work to perfect them.

Instead of the Government being eager to grab inventions, they refer all experimenters to the National Advisory Committee for Aeronautics, with the same result as the writer encountered when he asked Mr. Coffin to give an order for one each of three types of an improved airplane to be used for three different purposes—a polite letter stating he was unable to give any such order, as he was Chairman of the Aircraft Board in an *advisory* capacity only, and could place no orders no matter how fine the article or how much needed.

The Germans are said to have fallen behind as regards engines owing to their sticking largely to the old Mercedes design. Yet even *they* have not "put all their eggs in one basket," for they have in reality four to six different types and makes. In England there are 61 different types, as a result of which great progress has been made. The A. B. C. air-cooled radial motor is about the last word as regards a light, high-powered, multiple-cylindered engine. England has fully a half-dozen types that can be depended upon and that are up-to-date. I hope it is true that our policy has been changed and that we too are to develop different types and makes of motors.

Far better that we give our own inventors a chance—if they have something already developed—than that we import foreign motors and try to produce them in quantity as we have been doing of late, and as was our policy a year ago with the airplanes themselves, and is today with certain Italian bombing machines. How ridiculous and what a waste of time and effort that Italy should send a Caproni triplane here to fly across the Atlantic. Did we not build in this country the first large triplane and *ship* it to England? It had a spread of 131 ft., and has only lately been surpassed by the 141-ft. spread Gotha biplanes with four 300 hp. motors. Why do we not originate and build machines similar to the Gothas and fly them across from Newfoundland to Ireland—an 1800-mile trip

—in 18 or 20 hours? Bombing Berlin would be easy with such machines carrying 10,000 lb. of bombs. Equipped with four Liberty motors, such a machine could surely keep aloft for 24 hours.

Every aviator and observer should have a safety parachute, the same as does an observation balloon man, and thus be given a chance for his life. Raoul Lufberry would probably be alive today if he had had such a device. He deliberately jumped from his machine rather than be incinerated. The prevention of fire from backfire—the chief cause of the burning of machines other than fighters in mid-air—is now an accomplished fact by means of a certain device. Every engine should be equipped with it. The above are two safety devices that should be universally employed. Let us hope the day will soon arrive when Uncle Sam will have in use all the latest inventions, for it is Yankee inventiveness that the Huns fear most of all.

Stanley Yale Beach.

Scovill Manufacturing Co.

Our facilities are almost entirely occupied by direct and indirect Government work, very little of which is applicable to airplanes.

E. S. Sanderson.

Segul Aeroplane Co.

We are not trying to do contract work because the experimental stage has just been passed and are now building the large machine which has many new and modern features—a new departure in airplanes.

We have been sufficiently encouraged in experimental work but we are not capable at the present time to handle a quantity of additional orders, but we would be willing to help the greater production of machines.

E. N. Henzen.

B. F. Sturtevant Co.

I am inclined to think that it would be just as well to sit quiet and say nothing at this time. It is easy enough to criticize the past or the present, but I do not think anything is gained thereby. The damage that has been done to the whole aircraft industry is a mighty serious thing, and has delayed production weeks, if not months, in time.

These various investigations have also brought out all the recommendations which I could make and I feel sure that I could add nothing to the general program.

Benj. S. Foss.

Palmer-Simpson Corp.

We are at present, as you know, subcontractors on aircraft work for the Navy and as the public interest is centered in the Army, little attention is usually given us.

In business a year and a half, we have found little trouble in getting such contracts as our immediate facilities would warrant. We have greatly increased our facilities and have at present a large shop at Plattsburgh, N. Y., which is entirely idle. Our one trouble with contracts is the lapse of time between the ending of one and the beginning of the next, which in a specialty like ours means laying off the men and trusting to luck to be able to pick them up again in two or three weeks or a month. There are many men who finish their work long before the contract is completed and it should be possible to start them on parts for a new job immediately. This would hasten production by several months, but so far has been impossible.

For the production or inspection department of the Navy we have nothing but the highest praise. "Red Tape" is conspicuously absent and the spirit of cooperation and helpfulness from top to bottom is very gratifying.

Delays in receipt of drawings and specifications and changes after they are received are, of course, vexatious but probably necessary in the present stage of the art. Even this condition has vastly improved and drawings now are apparently meant to be built to.

We are, fortunately or unfortunately, considered a producing firm and our tentative efforts at experiment have been pretty generally frowned upon. Whether this is right or wrong I cannot say; however, we are turning out the stuff, which is what the Navy wants.

As the supply of practically everything one wishes to buy has been "taken over" by the Government, nearly all materials, while easy to order and glibly promised, are very difficult to obtain. It would seem possible to supply all recognized manufacturers and jobbers with a list of preferred buyers and their contract numbers and thereby kill a great deal of delay.

Of the financial question we can talk on both sides. We have waited a long time for our money and we have received it in five days. We have received advances for equipment and again we have been refused.

We have had little experience with cost plus contracts, just enough to convince us that the straight price method is far preferable. It permits of bonus work on the shop and we believe turns out work faster than the cost plus system with the best of intentions.

As to ourselves and our facilities, in an organization of over a hundred men, we have not one subject to the draft. We have a crew of skillful men, most of whom have been trained in this particular work for a year or more. We are and have been from the start willing to do anything which the Government asks. We have unused plant facilities to the extent of more than twice our present output and are prepared to start on new work in two weeks' time.

Dwight S. Simpson,
President.

Experiences of an Airplane Manufacturer

After repeated attempts and frequent trips to Washington, D. C., in an effort to get the proper Government officials to place an order with our firm for aircraft, or parts, in fact, anything, so that we could get our plant running on a production basis, and after numerous promises the writer was finally sent by one of the Government officials to inspect the production methods of two of the leading aircraft factories. In one of these plants they were not entirely equipped, therefore there was no production to be inspected, yet they had an order for quite a number of training planes.

The object of this inspection was to familiarize the writer with production methods in these plants so that our firm could handle the work expeditiously in the event of our being awarded a contract, which the writer had been promised upon his return to Washington, and which was made immediately after visiting the aforementioned plants. However, on my return to Washington, after spending considerable time and money, I was politely informed that their program had been changed, and that they could not give us the contract which had been promised before my visit to the plants.

After this fiasco at an attempt to obtain a contract, we decided that it was hopeless, and gave up the "Ghost," awaiting patiently the time when conditions in Washington would change.

All of these difficulties were encountered in spite of the fact that we had a fully equipped, modern, up-to-date plant, built for the sole purpose of manufacturing airplanes; and not an antiquated, obsolete type of woodworking plant which came into general favor as sub-contractors. Our plant had been inspected by a Government inspector and passed on very favorably. Our active head is a man of eight years' experience, both theoretical and practical, in aeronautics.

Had we been given the proper encouragement at Washington by their placing with our firm some kind of an order, we could have by this time increased our production 200 per cent, instead of being in the same position now that we were over a year ago.

From our experience we candidly believe that a plant to get maximum production should confine its efforts solely to one type of plane, if building complete machines, or if building parts to cut these down to the minimum and make the quantity specified sufficiently large to insure at least six months' operation of the plant at its maximum production. A small plant, working on parts, cannot be expected to become an efficient organization with only a small order and the prospects of securing additional business very remote. In our opinion, the business should be divided up, for under the present system some of the plants are hogging it all, while we are compelled to be content with a very small sub-contract not requiring more than one-tenth of our maximum facilities.

Experimental work in this country has been kept at a minimum, and especially so for a nation the importance of ours and possessing the ingenuity that this country has shown in all lines of invention; by all means there should be an appropriation made for experimental work on aircraft, for no doubt there is much latent talent awaiting the opportunity to show the world at large something new.

This letter is not intended to be one of criticism, but the facts are stated with the hopes that this letter, along with others, may have the desired effect of inaugurating a change in the present aircraft program, whereby all manufacturers who are equipped or capable of producing aircraft or parts—in this we refer particularly to some people who have been in the business for years and have been unable to obtain any recognition whatsoever—will be able to get an order of some kind, and thereby be instrumental in furthering our great aircraft program.

Whittemore-Hamm Co.

It is our frank opinion that much harm is being done aeronautical enterprises by the present ruling preventing civilian flying. We believe that private schools should be encouraged, that passengers should be carried, and that general exhibition work stimulates public attention and creates enthusiasm for aeronautical development.

Since the earliest days of flying, aircraft producers have been absolutely dependent upon exhibition flights, passenger carrying and pupils. Without the revenue from these sources all American constructors would have found it impossible to have continued their experimenting and the United States would not have had the few small concerns that were in existence at the outbreak of the European war which through foreign orders grew, and upon our entrance into the war became the sources of America's airplane and engine supply.

We believe civilian flying should be allowed under the following conditions.

1. License certain civilian pilots to fly over designated fields in specified machines, said machines to bear identification marks. Designated fields apply to areas so situated that no information of value to the enemy could be obtained, or where no military damage could be done.
2. Allow such licensed pilots to carry pupils or passengers over such designated fields.
3. Allow such licensed pilots without passengers to make cross country flights only upon special permit for each flight made. Special permit to be obtained from the Joint Army and Navy Board on Aeronautical Cognizance.
4. Civilian machines must not carry wireless, machine guns, or cameras.
5. Designated fields to be approved by the Air Service Department.
6. Pilots to be approved by the Air Service Department.

Williams Steel Wheel & Rim Co., Inc.

In the matter of the contracts for airplane parts, at the present time, we are doing practically nothing in the airplane line. We have about 12,000 sq. ft. of floor space which we can adapt to the making of rims or complete wheels—in both of which lines we have had long experience—should any one care to take advantage of what we have to offer.

D. H. Wetzel,
Sales Manager.

Motor Trailer for Airplanes

A novel type of motor trailer for airplanes, which has just been put on the market, should prove a valuable addition to the equipment of flying fields. This trailer, developed by the Fruehauf Trailer Co. of Detroit, Mich., operates in conjunction with a special light type tractor truck, produced by the Acason Motor Truck Co. of the same city, and permits to take on board a complete airplane by running it up on skids, and then haul it on the road at a goodly rate of speed to its destination.

The practise of hauling airplanes on the road is coming into use in certain sections of the country where it is desired to move machines without using their own power. In the case of disabled airplanes it proves handy to move the entire machine without dissembling it from wherever it may be to the repair shop so it may be given proper attention.

The trailer is 25 feet long, 7 feet wide, with racks 48 inches high. It is equipped with 38x7 Goodyear all weather tires on the trailer and solid Goodyears on the Acason Motor Truck Company's light type tractor. The trailer has a capacity of three tons. Its development is the result of French war experience.

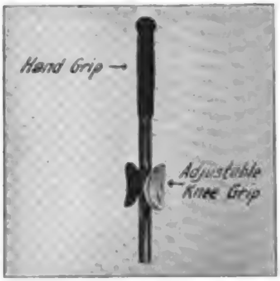
Tractor and Trailer Complete

It is believed that the combination will prove of much value in the commercialized aeroplane activity which is planned for the after-war period. It has caused favorable comment among prospective commercial airplane builders in Detroit, which city is looking forward to being one of the big airplane manufacturing centers at the conclusion of the war.

Warner Duplex Control Column

This stick control column is the invention of William Deshler Warner, 8 East Broad Street, Columbus, Ohio. It exercises the same functions in operating the control surfaces as other controls with the usual hand grip at the top. The particular advantage of the Warner control is an adjustable grip for the knees, which is easily adjusted while in flight to fit any size pilot. This installation makes the controlling of the plane with the legs a positive function instead of a haphazard makeshift.

The knee grip is an aluminum device shaped to fit the contour of the legs on either side, and vertical ribs to prevent forward or backward slipping, and so formed at the rear that if the column is pulled hard for an extreme climb it is not in the way of the pilot.



With the Warner control several pilots have been able to execute consecutive figure eights without touching the hands to the control, and flights up to 30 minutes' duration have frequently been made where the machines were operated entirely with the knees and feet.

Book Review

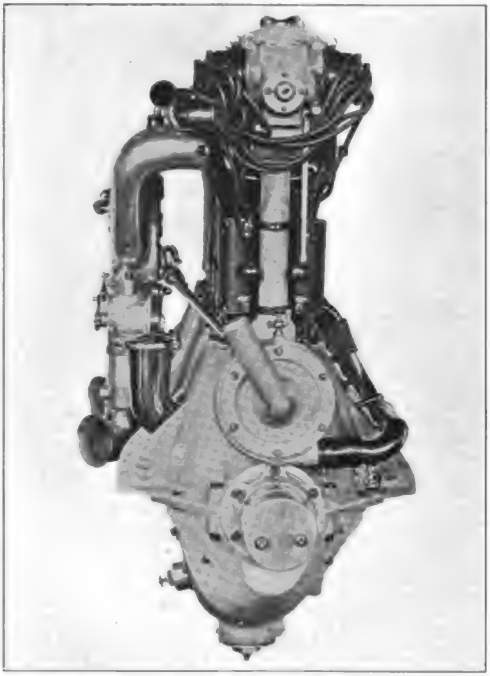
Glorious Exploits of the Air. By Edgar Middleton. D. Appleton & Co., New York and London. ($1.35. 256 pp., 4 plates.)

This book, written by a former Flight Sub-Lieutenant of the Royal Naval Air Service, describes in a vivid style the routine work and exploits of Great Britain's military and naval aviators and makes as such interesting reading for the non-initiated.

The Hall-Scott 6-Cylinder 200 hp. Airplane Engine

The success of the 6-cylinder 200 h.p. Hall-Scott airplane engine—the latest production of the pioneer aero-engine builders of San Francisco, Cal.—calls not only for a description of this remarkable American product but also for recognition of the progress made by this firm during ten years of airplane engine building.

The design of this engine—the model L-6—is not new but rather the result of ten years of progressive development. Since 1914 the Hall-Scott Motor Car Co. has been building six cylinder vertical engines of the A5 and A5-a models. The experience gained in checking results obtained on the test block and under actual flying conditions through quantity production under United States and foreign Government inspection has made possible the production of a fighting job in this new L-6 which will equal, if not surpass, airplane engines of other types and designs, either domestic or foreign.



End View, Hall-Scott Model L-6 Engine

The model L-6 is a 6-cylinder vertical engine, which develops 200 hp. and weighs less than 500 lbs.; it is 165 lbs. lighter and gives 50 hp. more than the A5 or A5-a models.

The L-6 is a simple engine, for the efficient engine of to-day must be the epitome of simplicity—an engine of no complicated designs or delicate elements—one that insures the maximum ruggedness to withstand the severe conditions imposed by the fortunes of war.

An airplane engine cannot receive the careful nursings of an expert engineer: it must function properly when taken care of by mechanics whose only training perhaps has been that received by Government instruction covering a limited period of time. This means that an engine leaving the factory and the watchful eye of experts must function and perform under adverse conditions.

The necessities of war have brought about a condition whereby men of little or no previous mechanical training must operate engines, over-haul them, tear them down and rebuild them, must make them run at sea level or 10,000 feet in the air, in summer or winter, wind or snow, rain or shine, night or day, over ocean or desert—exposed to every destructive force and element of nature.

A successful airplane engine must be designed for easy installation in planes of many designs—schooling, scouting, bombing and fighting planes—installed so as to be not only accessible to itself but to its control.

The prime essential of an airplane engine is strength. It must be so constructed that all moving parts have factors of safety far in excess of automobile engine types, for an airplane engine must not only be strong enough to withstand the stresses generated within itself, but strong enough to withstand and resist continuous running often with wide-open throttle for full power delivery.

The concrete crystallization of a design into a successful airplane engine is not, therefore, a simple problem. It is most complex—a problem in which all of the afore-mentioned factors and many more must be co-ordinated into a plane of logical sequence based on accurate knowledge and experience.

Since the first airplane engine was designed and built by E. J. Hall in 1908, many engines of various types have been produced for use in the United States and abroad. The knowledge and experience gained through the actual use of these engines in every part of this country, in the Phillipines, in Japan, in Russia, in Java, in the Netherlands and in other compilation of data that has proven most valuable in the development of the model L-6.

Exhaustive studies of extended experience has permitted the Hall-Scott Motor Car Co. to eliminate from designs all uncertain and undesirable features and has permitted the incorporation of some new and unusual features not to be found heretofore in any other engine.

The L-6 Engine

One of the primary considerations in the design of this engine was the securing of a compact installation. The result has been most pleasing, as the engine has less head resistance and permits the building of a more perfect streamline body around it than any heretofore built.

Power

As power in an engine is today of prime importance, this phase of the design was given most careful attention. The result is that the total mechanical efficiency, measured in output, is greater than any similar sized engine has ever developed. While rated at 200 hp. this engine will give a normal reading of 220 hp. at 1750 r.p.m. This result has been achieved by careful consideration of fuel distribution, valve action, and the factors governing thermal efficiency, reciprocating parts in relation to engine speed, etc.

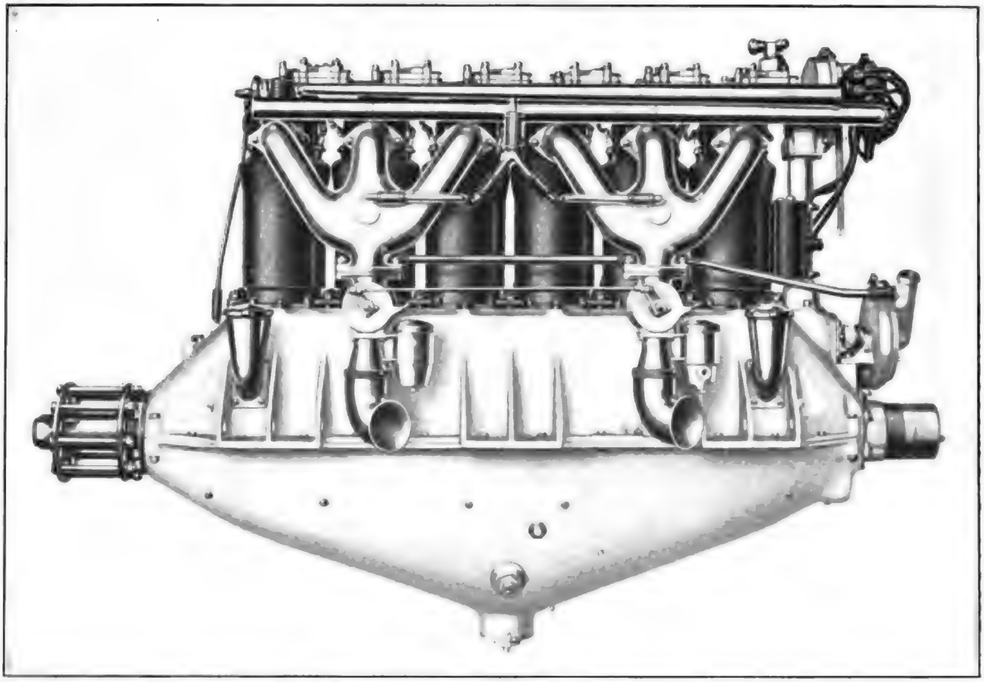
Fuel and Oil Economy

To obtain maximum cruising radius with minimum weight, the fuel problem was given careful consideration. Continuous experiments have shown a fuel consumption not greater than .55 lbs. of gasoline per b.hp. hour, with an oil consumption of less than one-half gallon per hour.

The arrangement of the valve, the diameter and lift and effective opening and the design of the manifold for the distribution of fuel, with specially designed carburetors, are all conducive to a high volumetric efficiency.

The construction of the cylinders, the method of jacketing, the circulation of the water induced by circulating pump but taking advantage of natural thermo-syphon principle, with due consideration to expansion factors; the piston design, clearance and heat radiation permits the highest possible thermal efficiency.

Observations on the field have demonstrated that carburetor adjustments are the cause of considerable trouble to flyers. Inexperienced field mechanics adjust carburetors so that too lean a mixture oxidizes the valve stems and burns out the seat,



SIDE VIEW OF THE HALL-SCOTT MODEL L-6 ENGINE

or a too rich mixture causes the engine to overheat and quite often flare-backs from pre-ignition.

To obviate and partially overcome these troubles, the range of water temperature has been made as great as possible, permitting the temperature to rise from normal of 160 degrees to as high as 200 degrees without injury to the engine.

The valves used in the L-6 are the same as used and found to be satisfactory, in previous 6-cylinder engines.

The carburetors are so arranged that danger of fire from flooding or flare-back can be eliminated.

Modern warfare demands many stunts of the flyer, such as nose and tail spins, looping, etc., and in many old style engines much trouble was caused by oil getting into the cylinders, fouling the spark plugs and causing mis-firing, as well as oil escaping and blowing into the face of the operator when the equilibrium of the engine was disturbed. These things have all been carefully considered in the L-6 with the result that this is as near an oil-tight motor as can be produced.

The oiling system has been devised utilizing a pump with a double lead so that in addition to distributing oil to the working parts of the engine, auxiliary oil tanks can readily be connected in case flights of long duration are necessary.

As the temperature, climatic conditions, differences in viscosity and gravity of the different lubricating oils bear a relation to oil pressure and feed, external oil relief valves have been designed that cover a range of pressure to 35 lb. per sq. in. A large capacity by-pass automatically operates at any set pressure which may be pre-determined by the operator to meet existing conditions.

Weight

Each element entering into the construction has been closely checked and analyzed so that each part can be made as light as possible yet maintain the highest stress factors. The weight of this engine is less than 2½ lb. per b.hp.

Ignition

While the model L-6 can be built to utilize any standard ignition system, experimental and first allotment of engines now under production have been fitted with the Delco system. This battery ignition has the following features.

1. Reliability. Two distinct distributor mechanisms, each one igniting all six cylinders through separate spark plugs. Each distributor head is fitted with two sets of breaker arms and contact points. Two distinct sources of electrical energy —battery and generator—are available.

2. Safety. The auxiliary breakers prevent the possibility of a back kick.

3. Great range of spark timing control. A spark of the same intensity is produced whether advanced or retarded through 360 deg.

4. Easy starting. A spark of the same intensity is produced at cranking speed as well as at flying speed.

5. Ability of pilot to tell whether the electric equipment is functioning properly through the medium of the ammeter.

6. Distributor heads are driven direct from the camshaft through a worm gear.

7. Long life. The distributor heads run at a slow speed (one half crank shaft speed), hence the wear is slight.

Conclusion

The general characteristics of the L-6 are as follows:

No. of cylinders	6	Propeller Dia.	9' 0'' } Average
Bore	5 in.	Pitch	6' 0''
Stroke	7 in.	Carburetor	Miller
Rated Horsepower	200	Cooling	Water—Centrifugal pump
Normal B.HP.	215	Ignition	Delco Battery
Speed	1,700 r.p.m.		

Piston displacement	824.570 cu. in. (137.445 cu. in. per cylinder)
Piston speed at normal	r.p.m. (1700) 1983 feet per minute
Compression volume	24.74 C cu. in.
Weight of engine dry, including carburetors, ignition system and propeller hub	500 lb.
Weight dry per normal hp	2.03 lb.
Water temperature inlet	140 deg. Fahr.
Water temperature outlet	160 deg. Fahr.
Water circulation	18.5 gal. per min.

The Clement-Bayard Rigid Airship

It is a little known fact that, though the rigid airship has been chiefly developed in Germany, particularly through the efforts of the Zeppelin and Schütte-Lanz concerns, the basic elements of this type of aircraft were first patented in 1873 by a French engineer, Joseph Spiess, a native son of Alsace.

However, the airship in general, and the rigid type in particular, never enjoyed a great deal of popularity in France, where the future of aerial navigation was always considered to be dependent on the success of the airplane, and consequently French airship designers and builders received little official encouragement in spite of the fact that some very promising types have been developed in that country.

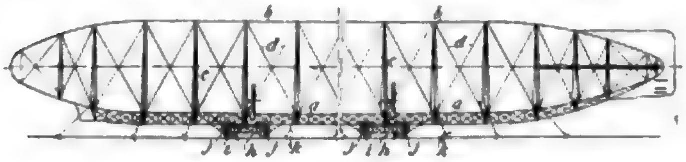


FIG. 1

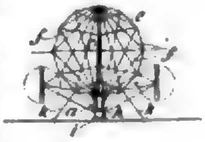


FIG. 2

Spiess himself, the father of the rigid airship, succeeded in having his design officially accepted only in 1909, after the disaster of the *République,* when he offered to cover the expenses of a rigid airship which was to have been built to his designs. This craft, the first French rigid airship, was actually built, and reached completion in the spring of 1913, at a time when the world's distance and duration records for airships had in a spectacular way been carried off by Germany's Zeppelin airships.

While it is true that the large airship of the rigid type has not proven all that the Germans expected from it, and has, in particular, signally failed as an offensive weapon, it is nevertheless recognized today in naval circles as affording an exceedingly valuable means for long-range naval reconnaissance, in which function it is still very much superior to the large flying boat.

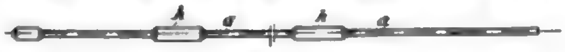
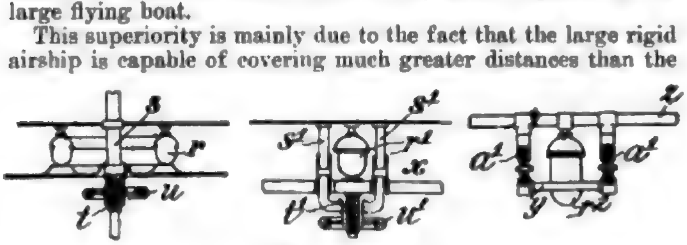


FIG. 3

This superiority is mainly due to the fact that the large rigid airship is capable of covering much greater distances than the seaplane, and also, because it can stay aloft regardless of engine failure, and can vary its speed so as to keep station with a fleet at sea.



FIGS. 4, 5, AND 6

Since the war began Great Britain is understood to have built several experimental rigid airships, and Japan as well as this country have been reported to have perfected plans for building such craft; on the other hand, Germany has never entirely ceased developing its Zeppelin and Schütte-Lanz airships, although, instead of employing them for offensive purposes, their use has of late been restricted chiefly to naval reconnaissance.

In view of the above considerations considerable interest may be elicited by the specification of letters patent issued by the United States Patent Office on May 7, 1918, to Adolphe Clément-Bayard, of Levallois-Perret (Seine), France, covering a new system of construction for rigid airships. M. Clément-Bayard is well known as the constructor of the non-rigid airships bearing his name, several of which, manned by French Army crews, performed satisfactorily in the early part of the war.

The specifications of the letters patent (No. 1,265,302) read as follows:

The present invention has for its object a dirigible of the rigid type, the girder of which is constituted in such a manner that it will withstand the strains due to its own weight when it rests upon two supports conveniently located at two points in its length. In combination with these conditions, it also relates to the employment of special devices for the deflation of the gas ballonnets; means for rapidly removing the outer envelope from the girder; of laterally guying the girder throughout its entire length, and if necessary for preserving one or two inflated ballonnets to contribute to maintaining the girder in its normal vertical position. The whole thus constituted has been established and combined in such a manner that it is possible in case a storm should break when the airship is resting unprotected on the ground, to protect it from the effect of wind capable of breaking it or of tearing it from its moorings.

FIG. 7

Figure 1 is a side elevation of my improved girder;

Fig. 2 is a cross-section thereof;

Fig. 3 is a plan-view of the communication passage;

Figs. 4 and 5 are detailed views of shock absorbers interposed between the car and the girder;

Fig. 6 is a detailed view of a shock absorber interposed between the car and the ground;

Figs. 7 and 8 represent a tearing bar in side and front elevation respectively;

Figs. 9 and 10 are elevational and plan views respectively of portions of a dirigible, and details of tearing mechanism operable from the platform;

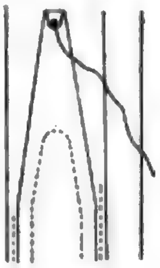


FIG. 8

Figs. 11 and 12 are views showing a cross-section and an elevation of a portion of a dirigible and details of the tearing mechanism operable from the ground;

Fig. 13 is a diagrammatic view showing another form of tearing mechanism;

Fig. 14 is a diagram of a form of tearing lacing;

Figs. 15 and 16 are cross-sectional and elevational details respectively of drums for winding and unwinding the blinds; and

Figs. 17 and 18 are cross-sectional and elevational views respectively of deflating mechanism for the ballonnets.

When a girder rests upon two supports, strains are produced in its various elements (uprights, diagonals, upper framework and lower framework); these are either compression or tension strains and their value is well determined. The girder generally comprises elements whose constitution cannot be determined solely by the conditions of resistance; certain conditions necessitated by its employment should also be considered. It will be understood that it may comprise elements which, owing to the dimensions of their section, would be particularly suitable for withstanding compression strains and that consequently it would be desirable, with a view to the minimum weight of the whole, to concentrate the said compression strains upon these elements; in this case the tension strains are reserved for the elements of reduced cross-section.

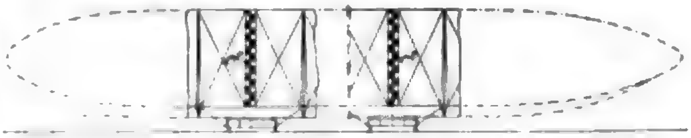


FIG. 9

This is the case with the girder for rigid dirigibles forming the object of the present invention, and which is represented in side elevation in Fig. 1 and in cross-section in Fig. 2. This girder is constituted in the following manner:

The lower framework by the communication passage *a* extending throughout its entire length and represented in plan in Fig. 3.

The upper framework by light beams *b*.

The uprights by vertical pylons *c* located in the median plane.

The diagonals by wires or cables *d* and finally, the transverse

News of the Fortnight

Reciprocal Patent Rights

The Senate on June 19 passed the Senate bill 3524 to extend temporarily the time for filing applications for patents and registration of trademarks, etc.

In the trading-with-the-enemy act it is provided that Germany and her allies may file applications in this country more than a year after having been filed in their own countries, whereas a citizen of a country allied with the United States must file in this country within one year from the time the application is filed in his own country; otherwise his patent when taken out here is invalid.

It gives to our Allies who are unable to file an application during the war or within six months thereafter, on account of conditions arising out of the war, an extension of nine months therefrom, but expressly excludes from this privilege countries whose laws do not extend substantially similar courtesies to United States citizens. It also relieves from default all applications filed since August 1, 1914.

Conservation of Platinum

The Bureau of Mines of the Department of the Interior has issued an appeal to the American people for the conservation of platinum, which is used, among other things, in the manufacture of ignition points in airplanes. Speaking in the House on June 7, Representative Henry T. Rainey severely criticized the War Industries Board for its unsuccessful, ineffective and wholly insufficient attempts to conserve the supply.

Aircraft Offices Move

The offices of the Bureau of Aircraft Production, including those of Director John D. Ryan and Chief of the Production Division Archer A. Landon, and the offices of the Aircraft Board, of which Mr. Ryan is chairman, have been removed to Building D, at Missouri Avenue and 4½ and 6th Streets, N. W., Washington, D. C. All these offices were formerly located on the ninth floor of the Munsey Building.

Besides the above, Building D now houses the office of Assistant Director of Production William C. Potter, the departments of the Production Division, the Department of Military Aeronautics, and the office of the Joint Army and Navy Board on Aeronautic Cognizance.

Aeronautic Cognizance Board

Rear Admiral William R. Shoemaker, representing the Navy, has been appointed a member of the Joint Army and Navy Board on Aeronautical Cognizance, in lieu of Capt. F. H. Clark.

First Lieut. W. W. Williams, S. R. C., A. S., has succeeded Capt. J. R. Whitehead as recorder to the Board.

The office of the Board has been removed from 1607 H Street, N. W., Washington, D. C., to the Department of Military Aeronautics, at Sixth Street and Missouri Avenue, N. W.

Aeronautical Instrument Corp. Formed

A. Haustetter has organized the International Aeronautical Instrument Corp., with offices at 308 Madison Avenue, New York City, to carry on the business of manufacturing altimeters, barographs, airspeed indicators and compasses. Mr. Haustetter is president and treasurer of the new corporation and A. Johns is secretary.

Castor Beans Import Licenses Revoked

The War Trade Board has made a new ruling that all outstanding licenses for the importation of castor beans and castor oil from the West Indies, Mexico, Central America, Colombia, and Venezuela, except those wherein the United States Government appears as consignee, have been revoked as to ocean shipment made after June 10, 1918.

Hereafter no licenses for importations from those countries will be issued, except when the United States Government is the consignee or when the importation is approved by the Bureau of Aircraft Production. All applications for the importation of these commodities from these countries when a consignee other than the United States Government is named will be referred to the Bureau of Aircraft Production for approval.

New Aviation Fields

Three new Army aviation fields will be put into operation before long. These are located at Babylon, N. Y.; Buffalo, N. Y., and Columbus, Ohio.

The field at Babylon, L. I., is situated on the site of the Belmont racetrack, which gained fame through the International Aviation Meeting held there in 1910. Two squadrons will be stationed at Belmont Field.

The new field at Buffalo will be an acceptance field for the final tests of machines delivered by the Curtiss Aeroplane and Motor Corp. Other acceptance fields are located at Detroit, Mich.; Elizabeth, N. J., and Dayton, Ohio.

Four hundred acres of land have been commandeered by the War Department as the site for the Buffalo acceptance field. The property extends from Elmwood Avenue on the east to Military Road on the west, to the town line of Kenmore on the north and to the Delaware & Lackawanna Railroad tracks on the south. The laying out of the field will require the closing of a section of Elmwood Avenue and twenty other streets.

Contracts for the construction of the necessary buildings on a cost-plus basis have been let to a Buffalo firm and the work will be begun at once. The property is valued roughly at $1,000,000.

About twenty hangars, eight storehouses, barracks for 500 men and quarters for officers will be erected. The estimated cost is $500,000, thus making the investment approximately $1,500,000.

The aviation camp to be established at Columbus, Ohio, will be situated on the Ohio state fair grounds. It will be used for preliminary training of aviators.

Practically every one of the large buildings on the grounds will be used for the students, and some remodeling and new construction will be necessary. Work will be started at once.

The aviation field established some time ago, two miles south of Austin, Texas, by the Chamber of Commerce of that city, has been leased to the Army for one year. The field has been named Penn Field, in honor of Cadet Eugene D. Penn, who was recently killed while flying in Italy.

Senators Visit the Standard Plant

The Senate Committee which is making a tour of inspection of the airplane plants visited the factories of the Standard Aero and Standard Aircraft corporations at Elizabeth, N. J., June 19.

Senator James A. Reed, of Missouri, speaking for the committee, said: "We find better conditions as to quantity production."

Other than this none of the Senators spoke, as the report of the investigation must first be made to the Military Affairs Committee of the Senate.

The other members of the committee are Senator Joseph S. Frelinghuysen of New Jersey, Senator Harry S. New of Indiana, and Senator Charles S. Thomas of Colorado.

Changes in Air Personnel Section

Lieut.-Col. W. E. Gillmore of the Air Personnel Division has been transferred to the Board of Control. Lieut.-Col. Franklin R. Kenny of the Signal Corps has succeeded Colonel Gillmore in the Air Personnel Division.

New Wind Tunnel

Throop College, Pasadena, Cal., is constructing a wind tunnel, and advices state that it is expected that it would be completed on or about July 15.

Aeronautical Commission to Go Abroad

Charles H. Willard, chief engineer of the Aeromarine Plane and Motor Co., has been given leave of absence by his company so he can join a Government aeronautical commission that is shortly to leave for France and England. It is understood that the purpose of the trip is to secure the latest military information upon aircraft and to translate it into production for next year's American airplane program. Colonel Hall and Major Marmon of the Aircraft Production Division are other members of the delegation.

Army Appropriation Bill

The annual Army Appropriation Bill, carrying a total of about $12,088,682,609.61, which passed the House last month, reached the Senate on June 24. No reduction was made in the bill as reported by Senator Chamberlain from the Committee on Military Affairs in the items of $884,304,758 for aviation and $105,946,054.77 for the Signal Corps, as adopted by the House, nor in any other item.

An increase of $47,000,000 is made by the Senate Committee and several amendments of a legislative nature are added as riders. Among them are amendments authorizing the formation of an aircraft production corporation with a capitalization of $100,000,000, empowering the President to commandeer timber for airplanes and other purposes.

Personnel of the Aircraft Board

Under the law the Aircraft Board consists of nine members, three of whom must be civilians, three representatives of the Navy and three representatives of the Army. The personnel of the Board now is composed as follows:

Civilians—John D. Ryan, Richard F. Howe and William C. Potter.

Navy—Rear-Admiral David W. Taylor, Capt. Noble E. Irwin and Lieut.-Commdr. Arthur K. Atkins.

Army—Maj.-Gen. William L. Kenly (who succeeds General Squier), Col. R. L. Montgomery and Col. E. A. Deeds.

Airplane Spruce Contracts

Contracts for airplane spruce were recently let by the Quartermaster's Department of the Army, as follows: Elmer G. Byron, Houlton, Me.; C. S. Dearing, Derry Village, N. H.; E. D. Hodgson, Cambridge, Mass.; H. Newton Dayter, Granville, N. Y.; Sherman Lumber Company, Sherman Station, Me.; H. H. Putman, Danforth, Me.; Kellogg Lumber Company, Long Point, Me.; Jackman and Garland, Lincoln, Vt.; S. W. Collins and Son, Caribou, Me.; J. F. Gerrity Company, Boston, Mass.; G. A. Mayer, Lincoln, Vt.; Nelson Murray, Lincoln, Vt.; S. G. Tisdale, East Middlebury, Vt.; Bentley and Butterfield, East Middlebury, Vt.; Farr and Kennedy, Rochester, Vt.; Rinaldo A. Whittier, Hancock, Vt.; N. D. Rice and Son, Granville, N. Y.; George H. Benn, Hodgson, Me.; Finch, Pryor and Company, Glen Falls, N. Y.; W. Edward Benson, Greenfield, Mass.; Martinon Lumber Company, Bangor, Me.; Pejepscot Paper Company, New York City; Emporium Lumber Company, Utica, N. Y.; Santa Clara Lumber Company, Tupper Lake, N. Y.; Ryther Purdy Lumber Company, Van Buren, Me.

Advertising Folder

The Aluminum Castings Co. of Cleveland, Ohio, manufacturers of Lynite and Lynux products, have recently sent out to the trade a folder advertising Lynite pistons.

Naval Air Mechanics Wanted

One hundred and twenty men are wanted at once for the Navy mechanics' school at the marine barracks, Philadelphia, Pa., now being organized. These men will enter the mechanics' school in classes of sixty, two classes, or 120 men, being wanted as soon as possible. Upon completion of the course at the school, and after receiving a course in gasoline engines, these men will be sent to aviation duty as mechanics. Men with experience as garagemen, mechanics, machinists, coppersmiths or welders are desired.

Men are also wanted to take the course of study at the school for aviation mechanics at Great Lakes Naval Training Station.

Men who have knowledge of gasoline engines, magneto work or carbureters, the taking up of bearings, fitting piston rings, assembly and machine tool work, are particularly wanted.

The advanced instruction covers practical work with all the latest types of airplane engines. All graduates are given ratings as petty officers, with a splendid chance for advancement.

Moving to Increase Production

The Pressed and Welded Steel Products Co., Inc., manufacturers of a large number and variety of Exhaust Headers and other airplane parts, will move from Flushing, N. Y., into new and larger quarters at Long Island City, which will afford facilities for increased production.

New Members of N. A. C. for A.

Several changes have just occurred in the membership of the National Advisory Committee for Aeronautics.

Maj.-Gen. William L. Kenly, Director of Military Aeronautics, has been appointed to the committee in place of Maj.-Gen. George O. Squier; Dr. Wallace C. Sabin, of the Bureau of Aircraft Production, succeeds Col. Virginius E. Clark, and Dr. John R. Freeman, of Providence, R. I., takes the place of Byron R. Newton, Collector of the Port of New York.

Doehler Die-Casting Co. Expands

The Toledo, Ohio, plant of the Doehler Die Casting Company, which is housed in a modern factory building completed about a year ago, has in this short time outgrown its quarters.

In order to provide for this expansion the company has found it necessary to take over the adjoining plant of the Ohio Electric Co., doubling its present capacity.

While a large part of the plant's activities are devoted to Government war work, the company attends to the needs of the regular trade.

Airplane Repair Depot at Montgomery

The Department of Military Aeronautics has in course of construction an engine, plane and repair depot at Montgomery, Ala. The work was begun on the building on or about April 15, and is being done by the Engineering Section of the Supply Division, Signal Corps, which under the reorganization is now a section of the Department of Military Aeronautics. The building is of wood construction, will cost about $100,000, and will be completed on or about July 1.

Klaxon Absorbs Stentor Co.

The Klaxon Co. of Newark, N. J., has absorbed the Stentor Electric Mfg. Co. of Long Island City, N. Y.

The Autophone and other loud-speaking telephone instruments formerly manufactured by the Stentor Co. will be marketed by the Klaxon sales organization.

The Autophone business will be handled from the Klaxon Co.'s office in the Hyatt Building, Detroit, Mich.

Search for Propeller Stock

The United States Department of Agriculture announces that the War Department and the Forest Service are aiding the Boy Scouts in efforts to find black walnut timber needed for airplane propellers, following President Wilson's appeal to the Scouts to locate supplies of the "Liberty Tree." Special report forms have been prepared for use of the Scouts, who will submit them for tabulation to the Forest Service, which in turn will report the results to the War Department.

The bulk of the standing black walnut is said to be in farmers' woodlots in the Middle West, the Middle Atlantic States, and the southern Appalachians, and it is mainly these sources that the Scouts will comb in their search for material.

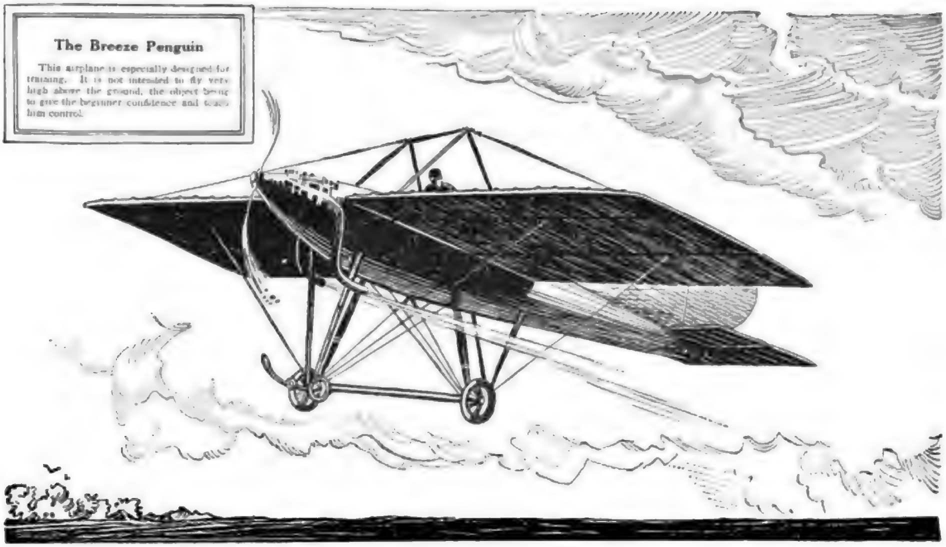
J. G. Bennett Pioneer in Aeronautics

Concerning the death of James Gordon Bennett, proprietor of the New York *Herald*, the London *Aeroplane* says:

Mr. Bennett endowed the International Balloon Race for the first three years of its existence with a trophy and a series of large prizes. The first race was held in 1906, the start taking place at Paris, the winner being Lieut. Lahm, an American pilot. Subsequent races were won successively by Germany, Switzerland, America, America again, France, and by America a third time.

At the first big public airplane competition held at Rheims in 1909, Mr. Gordon Bennett offered a trophy for the greatest speed round a marked course, which was won by Glenn H. Curtiss on a Curtiss airplane. The trophy which was international in character was open for competition every year, under rules determined by the F.A.I. Congress, were held up to 1914, when the outbreak of war stopped the race which would have been held in the late summer.

The Gordon Bennett Cup was won in 1910 by Claude Grahame-White on an 100 h.p. Blériot monoplane at Belmont Park, New York; in 1911, by Charles Weymann, on a 100 h.p. Nieuport monoplane for U. S. A.; in 1912, it was brought back to France by Jules Vedrines on a 140 h.p. Deperdusain, and kept in France in 1913 by Marcel Prévost on a 160 h.p. Deperdussin, who, for the first time in history, covered practically 125 miles round a closed course within the hour.



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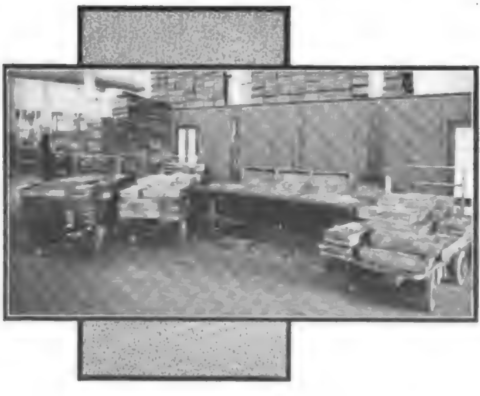

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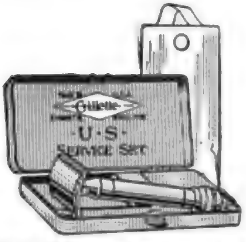

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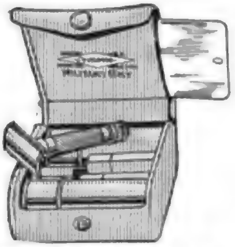

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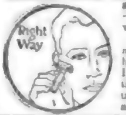

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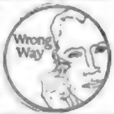

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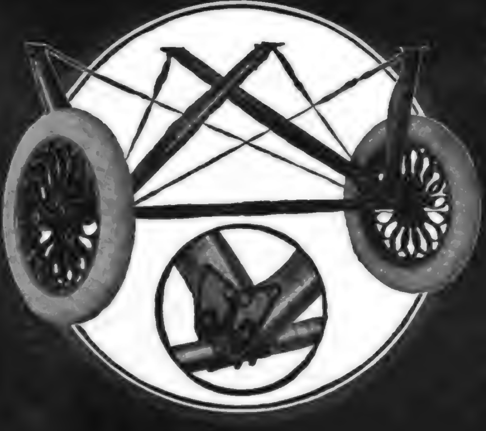

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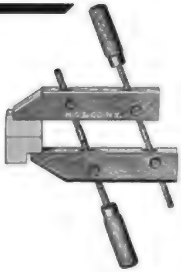

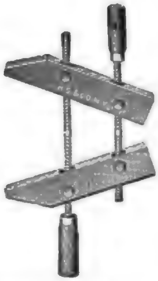

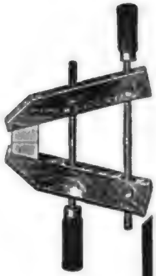

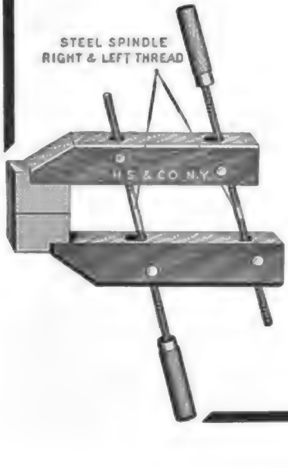

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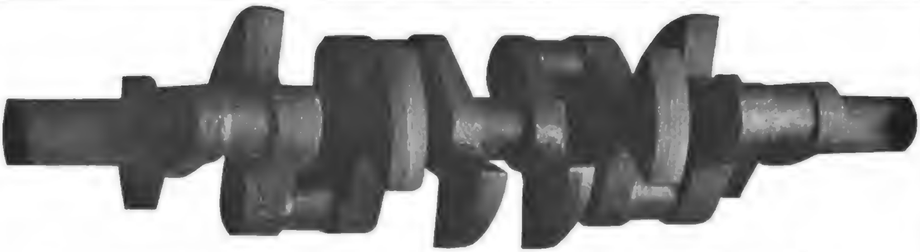

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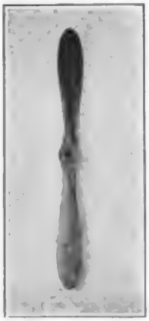

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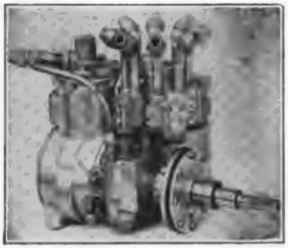

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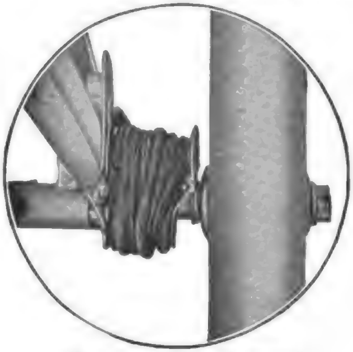

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Send inquiries regarding aluminum in any form to nearest Branch Office, or to General Sales Office

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2. "*Since your Penguin does not leave the ground there is nothing, of course, to stop the use of them.*"

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PROCEDURE:

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You then pay us a fee of $125, for which we prepare you to the point where you may safely go up alone in our airplane, which we rent you for 65c. each minute of actual flight, including the cost of breakage, with the proviso that you follow our instructions; because, while our Penguin practice makes the operation of the airplane in the air an easy matter, there still remain the principles of the landing to teach, which is easy by our system providing instructions are followed.

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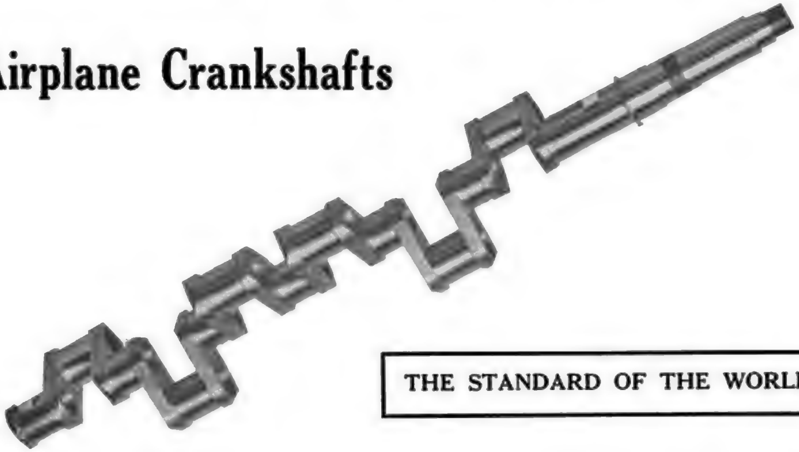

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For making light adjustments or repairs and making them quickly, a "Red Devil" Plier is most useful.

It saves hunting for the right size wrench. Its hexagon throat fits any size small bolt or nut. Has powerful cutters for wire, etc. File-cut jaw gives strong, sure grip. Heavy enough for hammer use. This

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Aeronautical Trade Directory

AVIATION AND AERONAUTICAL ENGINEERING will furnish information and addresses of companies listed below.

Names of Advertisers in this issue are printed in capitals.
See Index to Advertisers on page 832

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Advance Felt Specialty & Cutting Co.
INTERNATION AERONAUTICAL INSTRUMENT CORP.
King, Julius, Optical Co.
THE MOTO-METER CO.
National Gauge & Equipment Co.
O'Hara Waltham Dial Co.
Ricker, Walter.
SPERRY GYROSCOPE CO.
Standard Aeronautical Co.
TAYLOR INSTRUMENT COMPANIES
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SMITH, KYLE, AIRCRFAT CO.
Sperry, Lawrence, Aircraft Co.
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THOMAS-MORSE AIRCRAFT CORP.
The Willys-Morrow Co.
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SO-LUMINUM MFG. & ENG. CO. (SOLDER)
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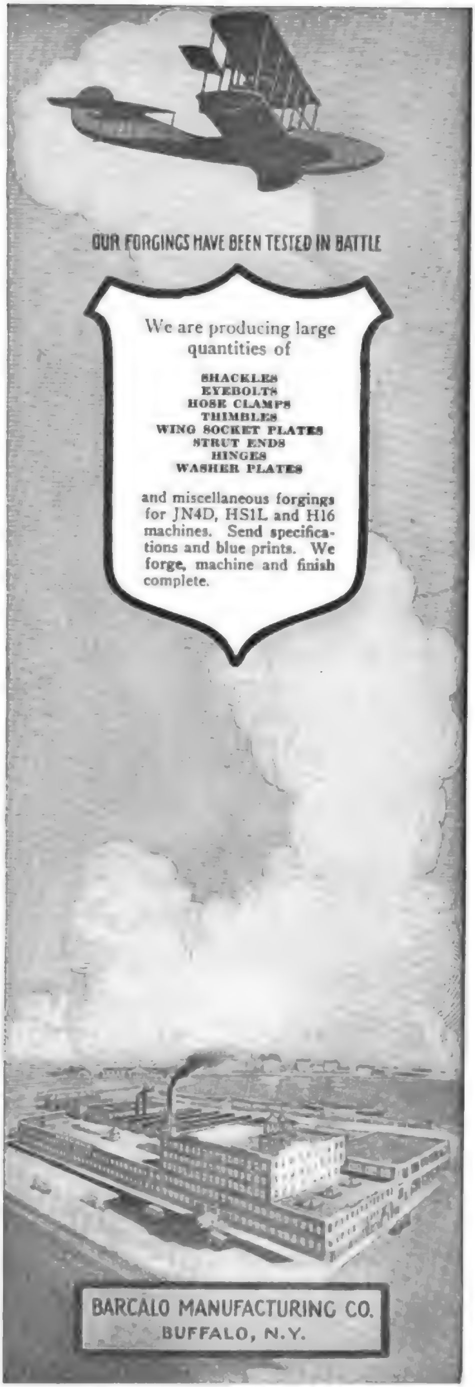
(Continued on page 821)



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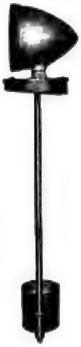
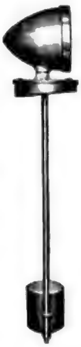


This cut shows our Model 51 Gage which is standard on practically all type of military training machines.

Other types of gages in large quantities are "doing their bit" as part of the equipment of English Government Warplanes.



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They possess every feature and qualification necessary for a high grade product.

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Used on the best American flying machines.

Our engineering department is at your service.

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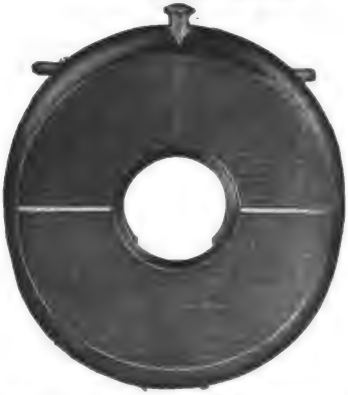

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Manufacturers and designers of
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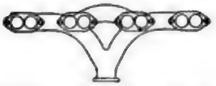

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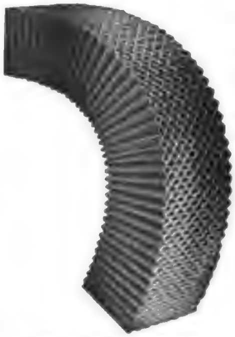

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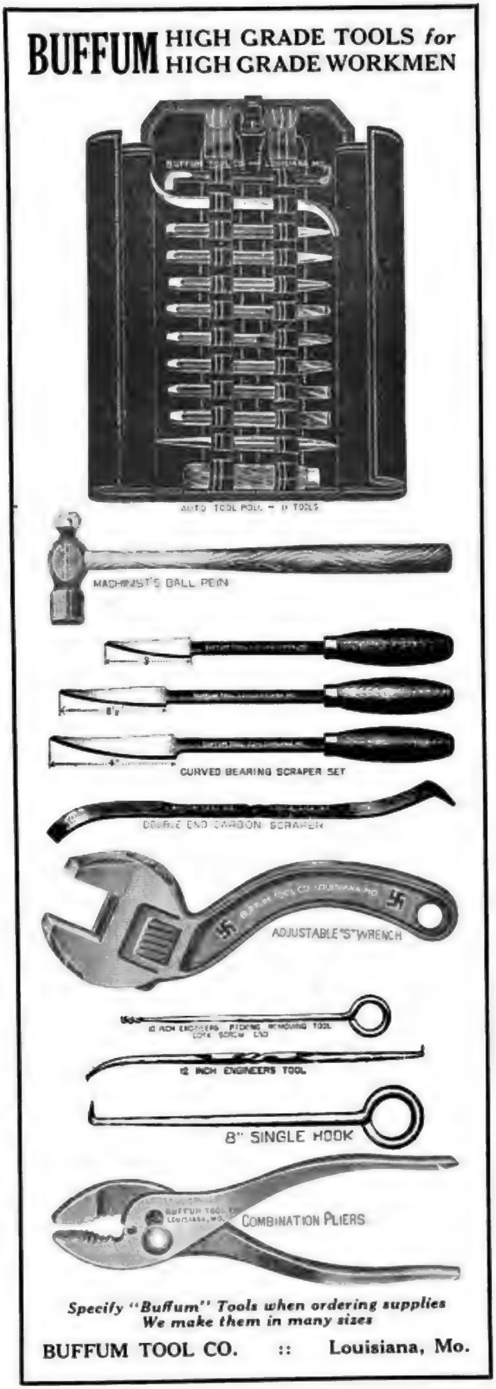

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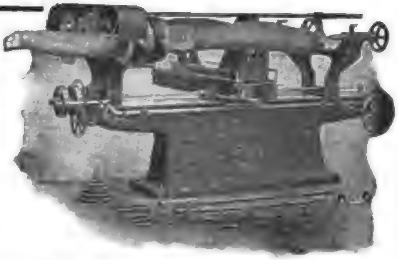

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"Dalton Six"

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One Manufacturer of fine instruments for aeroplanes now has

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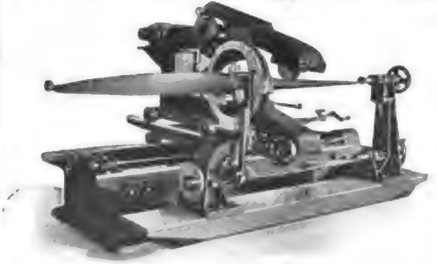

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ASTORIA VENEER MILLS & DOCK CO.
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Mengel, C. C., & Bros. Co.
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Cummings, W. L., Chemical Co.
RADIUM DIAL CO.
RADIUM LUMINOUS MATERIAL CORP.

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DEFIANCE MACHINE WORKS
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FOX MACHINE CO.
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PRYIBIL, P., MACHINE CO.
YATES, P. B., MACHINE CO.

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(*Continued on page 825*)

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Alight at Night

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A Self-luminous
Compound
made with
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Valuable scientific information for Watch, Clock, Compass and Instrument Manufacturers, who use luminous dials. Tells you how to select material that will meet your particular needs economically, and points out mistakes to be avoided. Contents, in brief:

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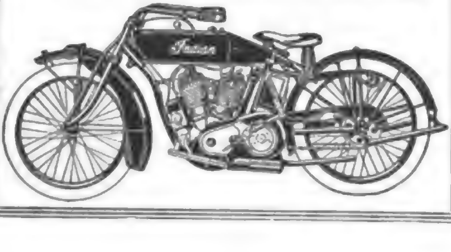

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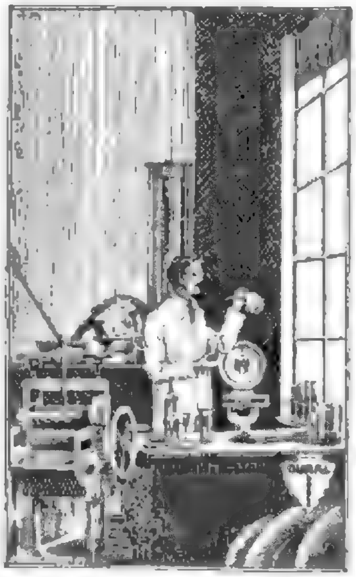

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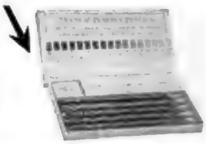

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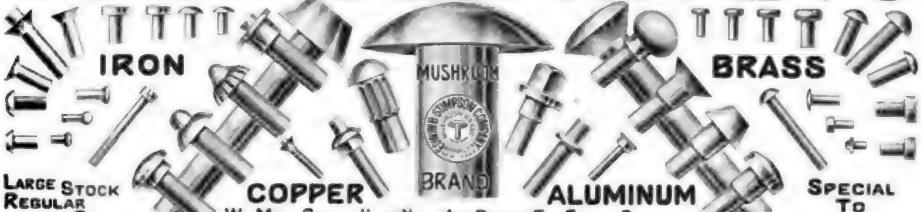

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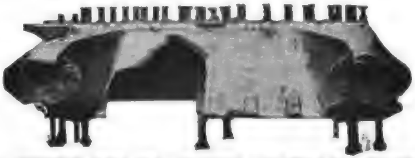

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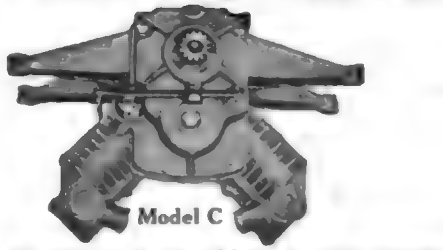

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THE PFALZ PURSUIT BIPLANE

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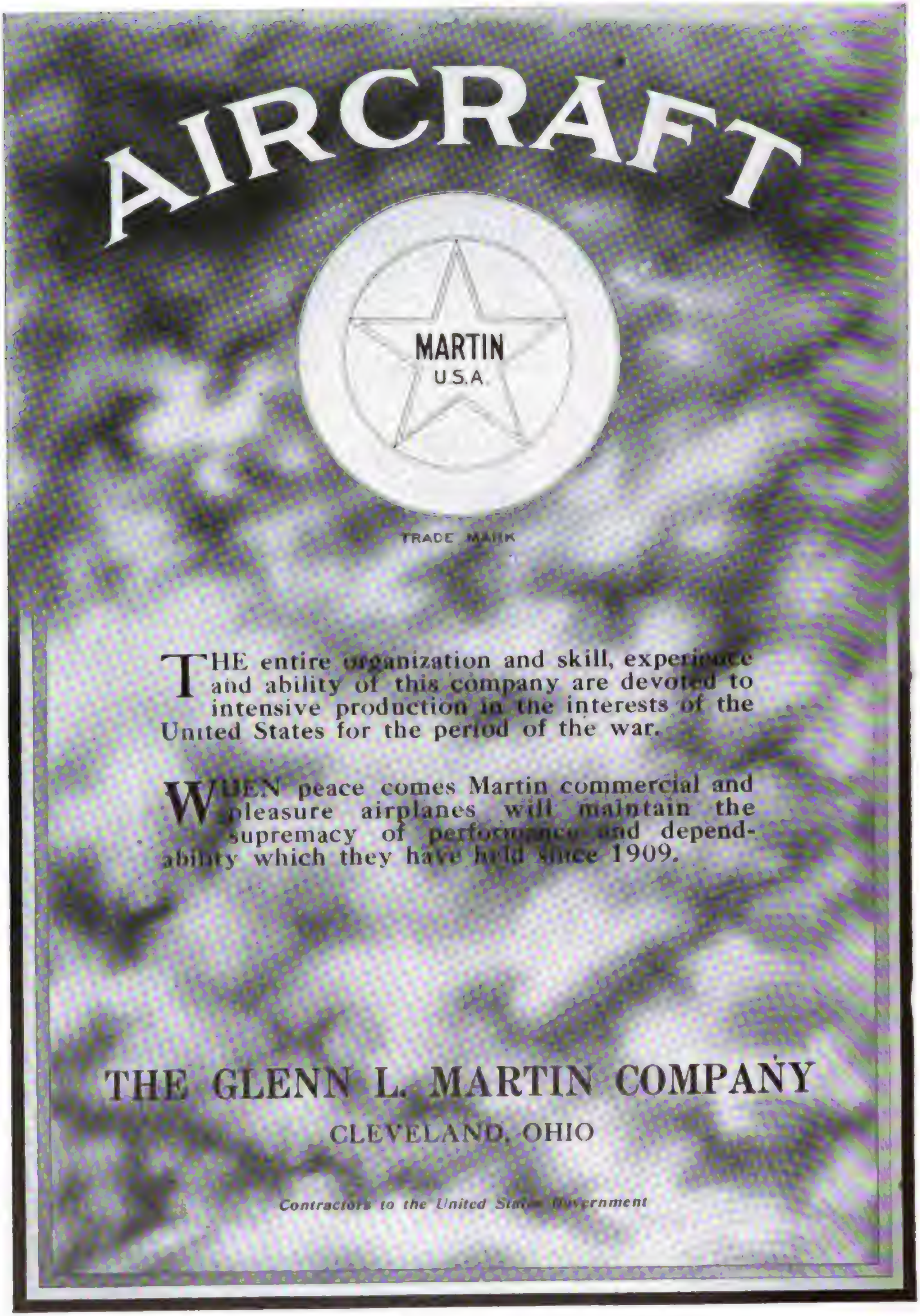

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JULY 15, 1918 AVIATION AND AERONAUTICAL ENGINEERING VOL. IV. NO. 12

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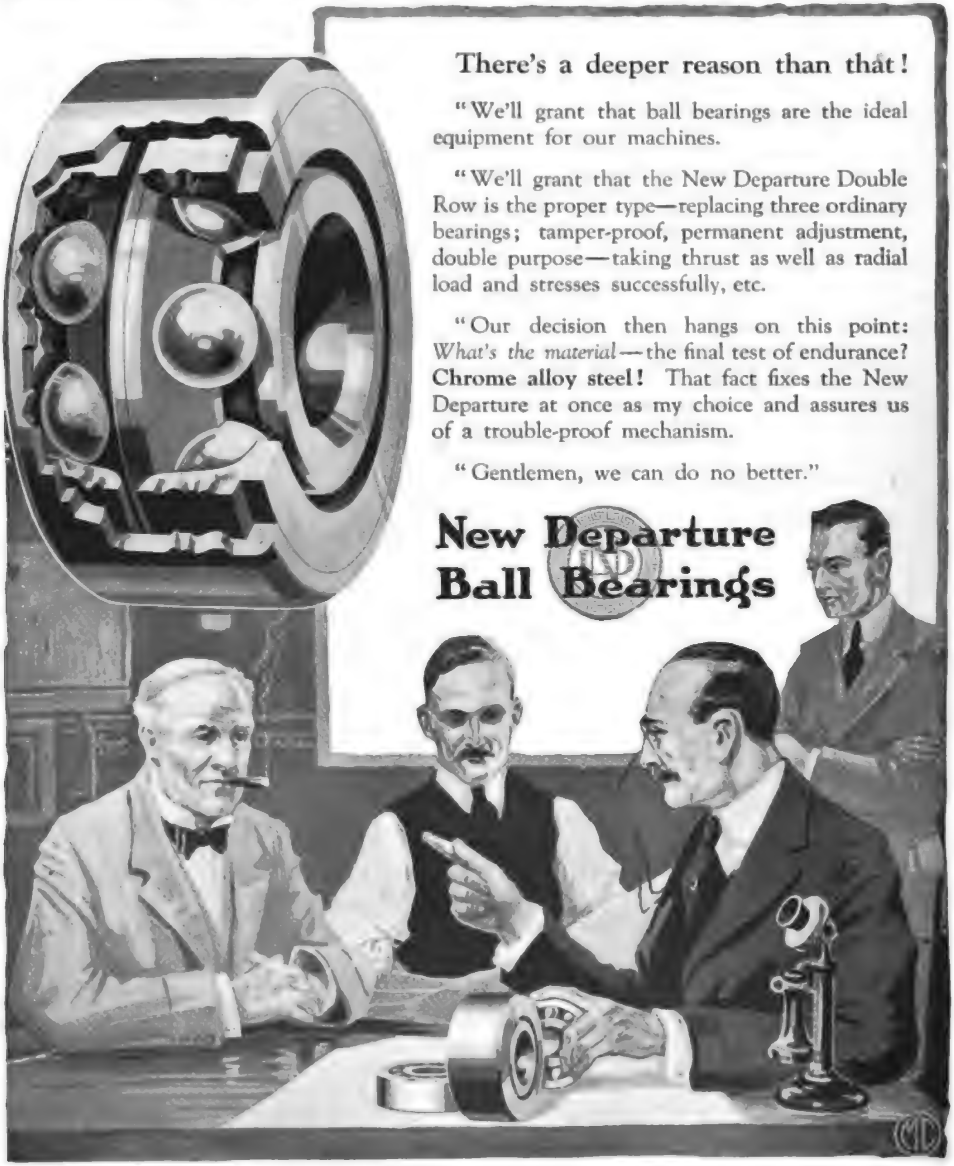

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Vol. IV July 15, 1918 No. 12

The First American Handley Page

During the past year the Standard Aircraft Corporation has covered practically the entire range of military types of airplanes, from the primary training machine to the large Caproni and Handley Page bombers. The intermediate types include an advanced training machine fitted with a Hispano-Suiza Engine, the M-Defense Scout with a Gnôme Engine, and the D. H. 4 combined reconnaissance, day bombing, and defensive fighting machine. The advanced training machine is the same type as the primary training machine with certain refinements and changes in the front end for the Hispano-Suiza Engine. The M-Defense successfully passed its first official tests without changes, on being demonstrated before officials at Washington at the Polo Field. The primary, advanced training, and scout machines are all from designs by Charles H. Day, Chief Engineer of the company.

The Standard company is the first in this country to complete either a large Caproni or Handley Page bomber. All production and engineering matters were left in the Standard company's hands. The Caproni was started on January 25 and left the plant the first week in May. The trial flights were delayed for six weeks, awaiting the receipt of Liberty Engines of more recent production numbers. The first flight was made July 4, and was successful in every respect. An interesting comparison between the two large bombing machines is afforded by the fact that the three-engined Caproni carries ten pounds to the horsepower, while the Handley Page two-engined machine carries twenty pounds to the horsepower. The fact that these two large foreign machines were reproduced in an American plant under American production methods in less than schedule time, and that they were 99 per cent perfect the first time they flew, is a performance which speaks well for the production of these types in sufficient quantities.

The main object of the public flights of the Handley Page at Elizabeth on July 6 was to visualize for the men and women employes of the Standard company what their splendid work and cooperation had accomplished, and to serve as an inspiration for the future. The enthusiasm of the workers who took in the speeches, the christening ceremony, and witnessed the flights was ample evidence that a good idea had been translated into performance.

Testing the Engines of the Langley Prior to Its First Flight

Central News Photo Service

At the same time the invited guests, officers of the Army and Navy, and Government officials, as well as the large number of citizens who witnessed the events from the side lines, carried away with them strong impressions of the magnitude of this country's efforts in the air, and a better perspective of what could be reasonably expected in the future.

The occasion also served to present in its proper light the magnitude of the proposition which has recently been given exaggerated publicity in the press, of building 10,000 Handley Page machines with which to bomb Germany off the map. In these statements it has been pointed out that the type of Handley Page completed by the Standard Aircraft Corporation was an obsolete model, dating from 1915. Definite information secured from representatives of the British War Board now in this country, Handley Page engineers, and an American officer who has just returned from a visit to the Handley Page works in England, places an entirely different aspect on these exaggerated statements.

The new airplane is an O-400 type, which had only been put in production by Handley Page early in April of this year. This machine is only sixty days behind the British production of similar types. The difference between the twin-engined O-400 type and the super-Handley Page is only the difference between the carrying capacity of two automobile trucks. The O-400 is now in production in England and it is

The A.E.G. Twin-Engined Bomber, G.105[*]

An A.E.G. twin-engined bomber, G.105, was brought down by anti-aircraft fire at Achiet-le-Grand December 23, 1917.

This machine, while carrying a similar power plant, is very different in construction from the Gotha type, which also embraces the Friedrichshafen Bomber.

The latter is generally constructed of wood, ply wood being used to a very large extent throughout, but in the A.E.G. steel is almost universally employed, not only in regard to the body, nacelle, subsidiary surfaces and landing gear but also in the wings themselves.

Needless to say, acetylene welding is freely resorted to throughout the construction, which, however, appears to be far from light.

On the whole, the A.E.G. airplane, judged by contemporary British standards of design, is decidedly clumsy, not only in detail work but also in appearance. The performance is poor.

The leading particulars of the machine are as follows:

Weight empty, 5258 lb.
Total weight, 7130 lb.
Upper wing area, 395.2 sq. ft.
Lower wing area, 335.2 sq. ft.
Total area of wings, 730.4 sq. ft.
Loading per sq. ft. 9.77 lb.
Area of ailerons, each, 17.9 sq. ft.
Area of balance of aileron, 1.8 sq. ft.
Area of tail plane, 34.0 sq. ft.
Area of fin, 11.5 sq. ft.
Area of rudder, 20.8 sq. ft.
Balanced area of rudder, 2.6 sq. ft.
Area of elevators, 31.2 sq. ft.
Balanced area of elevators, 3.6 sq. ft.
Horizontal area of body, 206.4 sq. ft.

Vertical area of body	209.2 sq. ft.
Total weight per hp.	13.7 lb. approx.
Crew—Pilot and two passengers	540 lb.
Armament	2 guns.
Engines	2 260 hp. Mercédès.
Gasoline capacity	123 gallons = 861 lb.
Oil	11 gallons = 110 lb.
Water	13 gallons = 130 lb.

Other dimensions are also shown on the drawings.

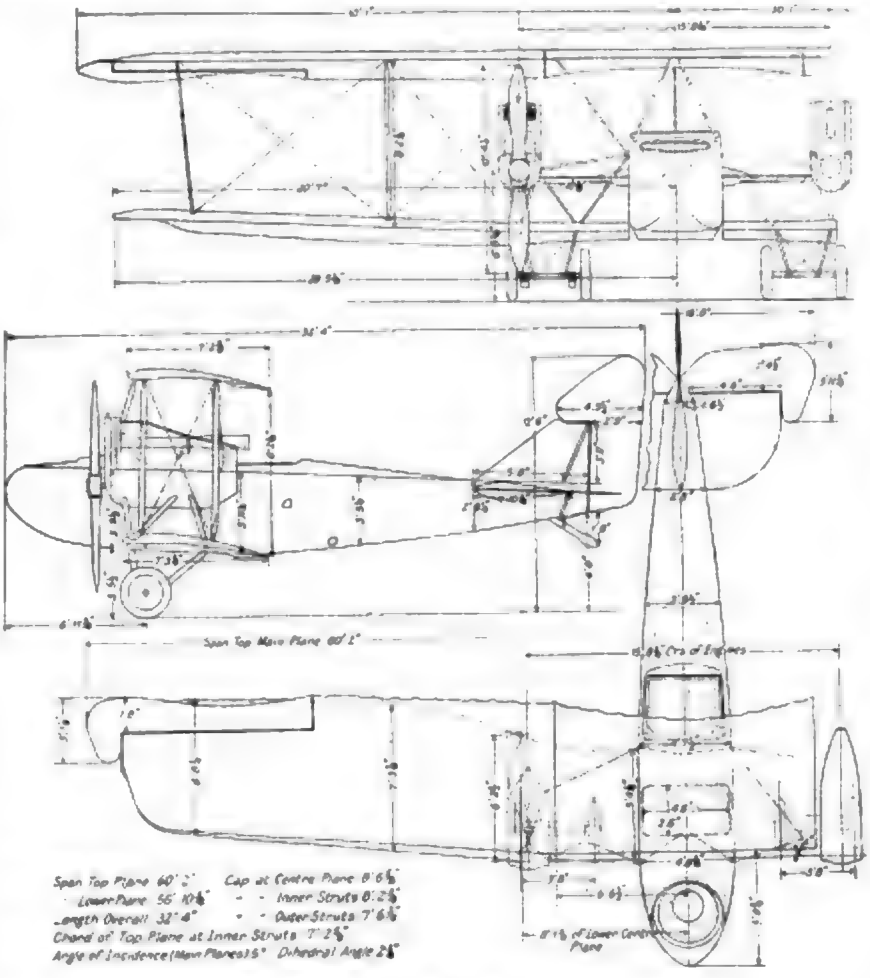
Span Top Main Plane 60' 2"
Span Top Plane 60' 2"
Lower Plane 56' 10⅛"
Length Overall 32' 4"
Gap at Centre Plane 6' 6⅝"
- - Inner Struts 6' 2⅝"
- - Outer Struts 7' 6⅝"
Chord of Top Plane at Inner Struts 7' 2⅝"
Angle of Incidence (Main Planes) 5° Dihedral Angle 2¾°

FIG. 1 SCALE DRAWINGS

Performance

(*a*) CLIMB, 5,000 ft. in 10.3 min.
  Rate of climb at 5,000 ft.—390 ft. per min.
 CLIMB, 9,000 ft. in 23.4 min.
  Rate of climb at 9,000 ft.—235 ft. per min.

(*b*) SPEED AT HEIGHTS
 Level to 5,000 ft.—90 miles per hour approximately
 At 9,000 ft.—86 miles per hour approximately

(*c*) LANDING SPEED
 The airplane is best landed at a speed between 75 and 80 miles an hour; after flattening out it sinks to the ground quickly and pulls up rapidly.

(*d*) CONTROL
 1 Lateral—Good
 2 Elevators—Bad, especially when landing

NOTE—It is stated that it is not advisable to fly this machine without a passenger in the front seat.

Construction of Wings—As will be seen from Fig. 1, the wings are of characteristic form. The central portion consists of a rectangular center cell permanently attached to the body. The lower wings support the engines. In this center cell the planes are set horizontally. At each side of it the lower main planes are swept upwards with a vertical dihedral of 2.75 deg., the top planes being kept flat, and both main planes are swept backwards in the horizontal plane to an angle of 4 deg. for the bottom plane and 3 deg. for the top plane. As the central portion of the upper main plane has 4 in. of negative stagger relative to the bottom plane, this difference in angle brings their tips practically vertically over one another. The angle of incidence attains a maximum of 4 deg. at the base of the engine struts—*i. e.*, 7 ft. 10⅜ in. from the center. At the second strut the angle is 3½ deg. and at the end strut 2½ deg. These angles are painted in circles on the surface of the planes, evidently for the convenience of riggers. The camber of both planes is washed out gradually toward the tips. The main spars are of steel tube and are 50 mm. in outside diameter, but their wall thickness is not at present known. In order to allow the thinning down of the wing section, these tubes are flattened out toward the extremity of the wing. They are chamfered down to a narrow end and a flat plate acetylene welded on to each side; thus at the spar tip the section is roughly rectangular.

The main spars are kept parallel throughout the whole of their length and are attached to the central cell by means of pin joints, similar to those on the Friedrichshafen. The ribs are of solid wood and are constructed as shown in Fig. 2. It is rather notable in comparison with other German machines of all types that ply wood is almost entirely absent. In the A.E.G. construction the rib webs are perforated and strengthened by wooden uprights at intervals and are glued into a grooved flange. The ribs are placed 300 mm.— 325 mm. apart, and are not directly or firmly attached to the spars, on which they are a relatively loose fit.

Passing through the ribs of the bottom plane and extending from their junction with the center section to the extreme outside strut are two steel tubes, approximately 17 mm. in diameter, which act as housings for the aileron control wires. These tubes are very strong, and it is thought possible that they are also counted upon to lend rigidity to the wing structure. The leading edge, which is of the usual semicircular section, acts as a distance piece, as also does the wire trailing edge. Thirteen inches in front of the last named is a stringer formed of a steel rod. Apart from this, the spars are the only longitudinal members of the wings.

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[*] Report issued by the Technical Department of the Department of Aircraft Production, British Ministry of Munitions.

Between the main ribs are false ribs running from the leading edge to a point a few inches behind the leading spar and applying only to the upper surface. One of these false ribs is sketched in Fig. 3. It is secured by means of a semicircular saddle and a wrapping of tape which passes as shown through holes in the rib. Where it meets the leading edge it is furnished with triangular packing pieces, which locate and hold it in position. The lower plane is covered as to its upper surface with sheet metal immediately under the engines, while between them and the body is fixed a strip of corrugated aluminum which acts as a footway. The fabric is attached in the usual manner and is stitched to the ribs both top and bottom. The two surfaces are stitched together behind the metal rod, which acts as a stringer, and by this means the actual trailing edge wire is relieved of a certain amount of tension.

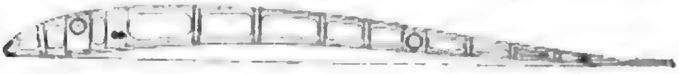


Fig. 2

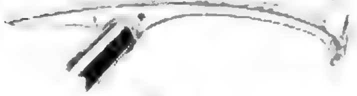


Fig. 3

The wing structure is internally braced by means of steel tubular cross-pieces and stranded cables. A single fitting is employed for the attachment of the interplane struts and for that of the bracing tubes. This fitting is shown in Fig. 4. It is a tight fit on the spar, to which it is fixed by a bolt, and is formed with an extension lug which acts, as shown, as an anchorage for the bracing tube, whilst a sideways extension of the same lug carries an eye for the bracing wire. It is provided with a cup-shaped upper extension, into which there is screwed a steel dome which carries the ball of the strut socket fitting and also acts as a wiring plate for the interplane bracing wires. As shown in the sketch, the fabric is run into the space between the upper and lower flanges of this fitting, the whole making a very neat job.

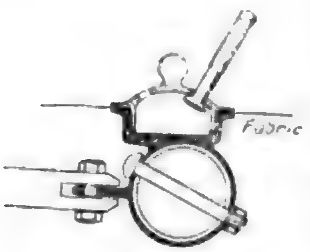


Fig. 4

Struts—These are of streamline section steel tube and of uniform dimensions throughout. The section is 92 mm. long by 48 mm. broad. The ends are sharply tapered down, and into them is welded a cupped ferrule which drops on to the ball shown in Fig. 4 and is there held in position by a cotter pin. The attachment is shown complete in Fig. 5. This joint gives a considerable range of lateral freedom, as is the usual practice on machines of German design.

Body—The whole of the body is built up of steel tubes welded together. It is of plain rectangular section and the cross tubes are attached directly to the main booms without the intervention of any clips. This detail of construction is shown in Fig. 6, which also illustrates the single and double lugs which are used for the purpose of securing the bracing wires. Under the nacelle and in the neighborhood of the main gasoline tanks and the bomb racks the body is reinforced with thin tubular steel tie-rods. Fig. 7 shows the manner in which the upper booms of the body are provided with sockets for the inclined struts of the central cell. The fitting consists of two circular steel plates welded into position to form an integral part of the frame joint, the front one of these flanges being provided with lugs for the anchorage of bracing cables. The inclined struts are secured by a ring of short set screws wired together as shown. If appearances are to be trusted this form of attachment, while being strong and convenient, is excessively heavy. Unlike the practice which is pursued in the Friedrichshafen Bomber, wherein the main frame consists of three separate sections, that of the A.E.G. is in one piece from stem to stern. The longerons are 30 mm. in diameter and the transverse members 30 mm., these dimensions being retained up to the extreme tail end. The nose part of the frame is covered in with three-ply wood, but behind this a double covering of fabric is used, under which the tubular construction is completely hidden. Behind the after cockpit a single covering only is adopted and laced the whole of its length so that it is removable in its entirey.

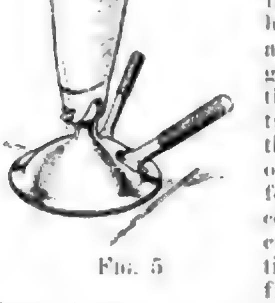


Fig. 5

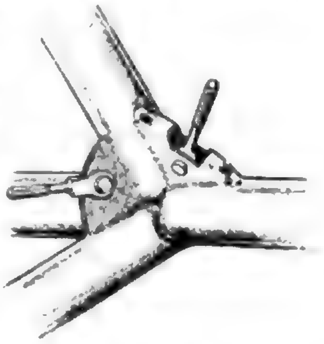


Fig. 6

Engine Struts—These are of streamline steel tubing and embrace joints of a somewhat similar type to those used on the interplane struts; that is to say, a certain amount of free movement is provided. The mounting of the engines is clearly shown in the front and side elevations. In front there are four struts which converge to a joint on the leading spar, while at the rear there are two struts which meet at a joint on the trailing spar. The attachment of the former is shown in Fig. 8. The bell-shaped housing attached to a cup on the spar joint contains a ball-ended setscrew, which screws into the foot of the four struts which are here united by welding. The inclined transverse struts are taken from the spars to the engine mounting and cross struts from thence again to the upper booms of the fuselage. In order to provide simplicity of erection these subsidiary struts are provided with a means of adjustment as shown in Fig. 9. At one end they terminate in a ball-ended setscrew screwed into the tapered end of the strut and secured by a lock nut.

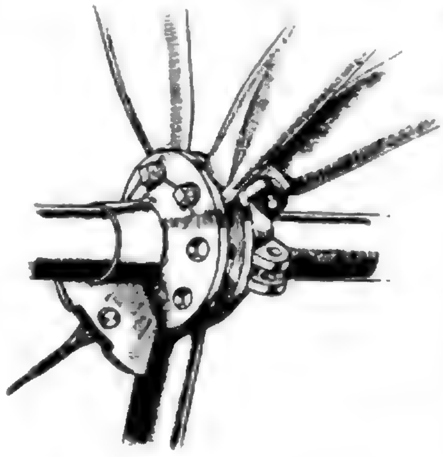


Fig. 7

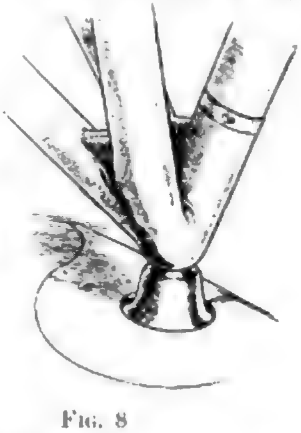


Fig. 8

Engine Mounting—The engine bearers are of steel rectangular section, measuring 40 mm. high by 30 mm. broad, with a wall thickness of approximately 2 mm. These bearers are welded to the struts which support them, as shown in Fig. 10, and for the greater part of their length are reinforced by a system of tubular tie-rods also welded in position. Box attachments welded to the engine bearer, as shown in Fig 11, are provided for the crank chamber holding-down bolts. The engine is not directly mounted on the steel bearers, but upon ½ in. wooden washers. Owing to the deformation inseparable from so much welding the engine mounting is of very clumsy appearance, and, in fact, the quality of welding does not appear to be up

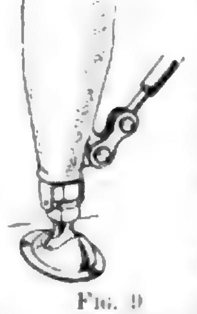


Fig. 9

to previous German standards, but the construction would appear to be light.

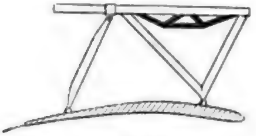


FIG. 10

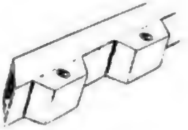


FIG. 11

Engine Fairing—As shown in the photographs, the engines are almost completely enclosed in a fairing composed of detachable aluminum panels. The necessary framework and clips are provided for panels totally enclosing the engine, but it would seem that this bonnet right over the heads of the cylinders has been discarded. The tubular framework which supports the panels is an elaborate piece of work, comprising a multiplicity of welded joints. It consists of 16 mm. tubes, to which are attached lugs for carrying the necessary turnbuttons. The framework is made in two halves so as to be easily detachable, and a joint for that purpose is made, as shown in the sketch Fig. 12. It will be noticed that a narrow slot for the exit of air passing over the engine is provided at the rear end of the engine egg, an opening of somewhat similar dimensions being between the two halves of the radiator.

Engines—The engines are the standard 6-cylinder 260-hp. Mercédès. A new shape has been adopted for the exhaust pipe, and this is clearly shown in Fig. 13—an inverted cone is placed in the belled mouth of the pipe. The usual water pump greaser is fitted and worked by a lever in the pilot's cockpit. It is of rather less clumsy design than that of the Friedrichshafen, but employs virtually the same principle. The throttle is interconnected with the ignition advance as described in the Friedrichshafen report. A small fitting, the purpose of which is not very clear, is attached to the carbureter, and consists, as shown in Fig. 14, of a bell-shaped cover over the top of the float chamber, not directly connected thereto, but supported on a bracket clipped to the main water pipe. The bell is free to slide up and down the stem of the bracket, on which it is a very loose fit, but is prevented from falling over the float chamber by a small washer. It is conjectured that this fitting may have for its purpose the prevention of fuel having access to the hot exhaust pipe in the event of the machine turning over. Between the bell and the float chamber is a clearance of about ¼ in.

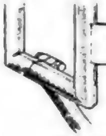


FIG. 12

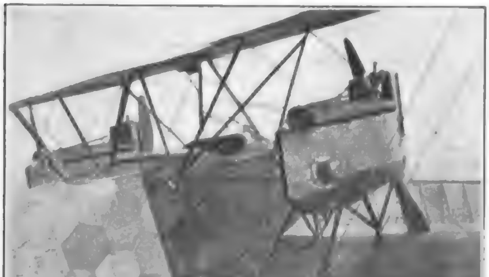


FIG. 13 THREE-QUARTER REAR VIEW OF BODY AND ENGINE MOUNTING

Gasoline System—The gasoline system employed on the A.E.G. is set out diagrammatically in Fig. 15. There are two main tanks, each of 270 liters = 95 gallons total capacity, and these are placed under the pilot's seat in the main cockpit. Two subsidiary tanks used solely for starting purposes and giving a gravity supply are mounted in the center section of the top main plane and are of roughly streamline form. Beneath them is a small cowling containing their level gauges, which are visible from the pilot's seat. On the right-hand side of the main cockpit is fitted a hand-operated wing pump, the object of which is to draw gasoline from either of the main tanks and direct it to the gravity tanks. Pipes from all four tanks are taken to a distributing manifold on the dashboard, and by means of seven taps thereon the supply of gasoline can be directed from any one of the tanks to either engine or both. Two additional taps are provided on the wing pump, so that the fuel for the gravity supply can be drawn from either main tank as required. Fig. 16 clearly shows the arrangement of the gasoline taps, which are of the plain plug type. It would appear that the troubles associated with this form of tap have been overcome, as they show no signs of leaking or sticking. The level of the main tanks is indicated on the dashboard by two Maximall gauges. Those attached to the gravity tanks are made by Laufer and employ the static head principle. They read up to 45 liters each, from zero to this figure being given by one and a half complete revolutions of the indicating hand.

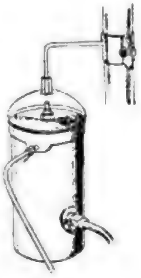


FIG. 14

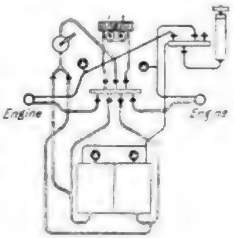


FIG. 15

Gasoline Pressure System—The sketch Fig. 15 also shows in solid lines the arrangement of the gasoline pressure system. The usual pressure pump is mounted on each engine, and pipes therefrom are led to a manifold mounted on the dashboard. This is also connected to a large hand pump on the right-hand side of the pilot's seat. Gauges reading the pressure from each engine pump are provided, and there is also a blow-off tap for relieving the pressure of the whole system.

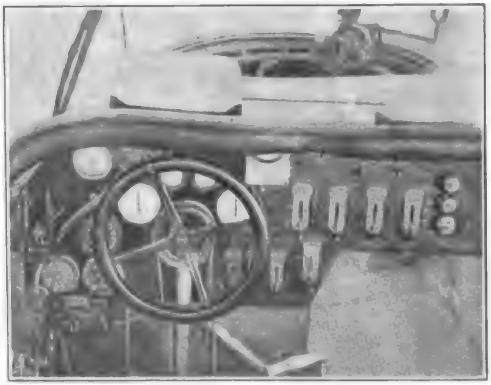


FIG. 16 INSTRUMENT BOARD IN PILOT'S COCKPIT

Oil System—This is the usual system as fitted to all 260-hp. Mercédès engines. The main supply of oil is carried in the crank chamber sump, and is continually being refreshed by a small additional supply of fresh oil drawn from an external tank. This tank has a capacity of five gallons, is of rectangular shape, and is mounted at the side of the engine nearest to the fuselage. It is provided with a visible glass level, over which is a celluloid covered window let into the engine fairing, so that the oil level is visible from the pilot's seat.

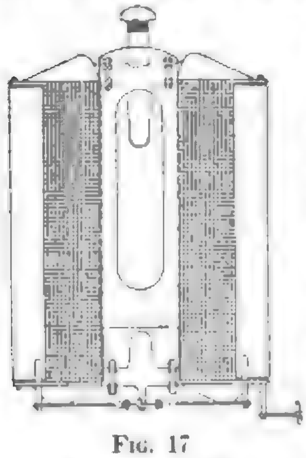


Fig. 17

Radiator—Each radiator is composed of two halves bolted together, as shown in the sketch Fig. 17, which is to scale. The space between the two halves is partially covered with a sheet metal panel pierced with a hole 1 ft. 6 in. high by 4 in. wide. The radiator is not actually honeycomb, though presenting that appearance. It consists of a series of vertical tubes with transverse gills. Each radiator cell measures 2 ft. 3¼ in. high by 7½ in. wide, and has a uniform depth of 4 in. Each complete radiator is provided with two shutters of roughly streamline section. These, when fully closed, cover over about one-third of the radiating surface.

They are controlled from the pilot's seat by two levers shown in Fig. 18, which work them through universally jointed rods. The articulation in these rods is very neat, and of the form shown in Fig. 19. Each radiator is fitted with an electric thermometer. The dial of this instrument is carried on the dashboard, and is furnished with a switch, enabling the temperature of either radiator to be independently read.

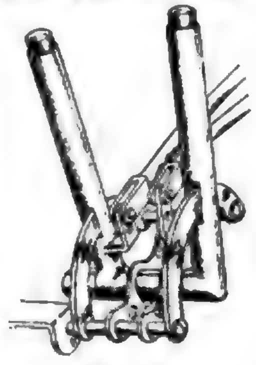


Fig. 18

Engine Control — The throttle levers are of the plain twin variety, and are constructed as indicated in sketch Fig. 20. They are placed close together so as to be easily worked either in unison or separately. The connections between the levers and the carbureter are made as simple as possible, and the levers operate the throttle through a couple of universally jointed rods which extend from each side of the body to the engine eggs. The universal joints used are of the type shown in Fig. 21, there being apparently no particular desire on the part of the designer of the machine to economize weight in these details.

Tail Planes — The fixed horizontal tail planes are notable for their extremely bold curvature, both top and bottom. The framework consists entirely of welded steel tubing. The leading edge of the tail plane is mounted so as to be adjustable in case of necessity, a simple bracket being used for this purpose, as illustrated in Fig. 22. This is welded on to the body upright at each side and strengthened with a transverse stay. It allows the tail plane leading edge to be fixed in one of three positions. The trailing edge of the tail plane is supported each side by a streamline section steel tubular strut.

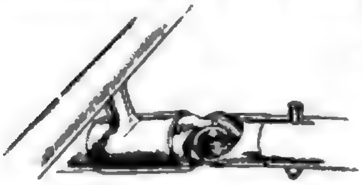


Fig. 19

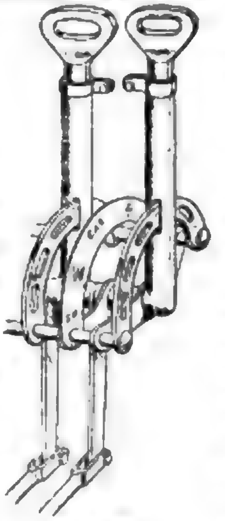


Fig. 20

Fin—The fin, like the fixed tail plane, has also a very strongly marked streamline section at the base tapering off to flat at the top, where it abuts against the balanced portion of the rudder. At this point its framework, which is of light steel tube, is made rigid by a couple of tubular stays bracing the rudder post to the sides of the body.

Rudder and Elevators—These organs are built up of steel tubular framework and present no points of special interest, except that in the case of the rudder that part which is above the fixed fin is made of grooved section.

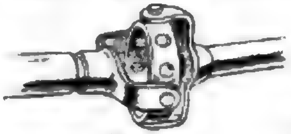


Fig. 21

Ailerons—As may be seen from the plan view of the complete machine, the shape of the ailerons is somewhat unusual. These are applied to the top plane only and have a chord which reaches its maximum at their extreme ends and its minimum in the center of their length. For what purpose this peculiar shape is adopted is not clear. The framework of these ailerons is welded steel tubing, and the control crank is fitted in such a way as to lie partially hidden in a slot in the main plane. This crank is built up of welded sheet steel, and is arranged as shown in the sketch, Fig. 23, an elliptical hole being cut in the trailing edge of the main plane for the passage of the forward wire.

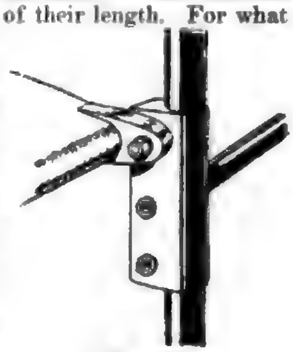


Fig. 22

Control—The main control consists of a wheel mounted on a pivoted lever, the wheel operating the ailerons by means of a drum and cables, which pass direct over pulleys and along tubes running parallel with the wing spars and then over inclined pulleys up to the aileron cranks. The wheel column is pivoted to a long crossbar extending the whole length of the body and carrying at each end cranks for the elevator control wires which at intervals are carried through fiber guides socketed to the frame. The cranks of the elevators are concealed inside the rear end of the body, while those of the rudder (which is fitted with duplicate cranks and wires) are external. A modified dual control is fitted, which allows the assistant pilot to work the elevator and rudder only. For this purpose a socket is mounted on the pivot bar into which can be inserted a plain steel tube which is normally carried in clips behind the pilot's back. A second rudder bar, the design of which is shown in Fig. 24, is carried under the dashboard and can readily be dropped into position into a square socket partially sunk into the floor of the cockpit and connected to the pilot's rudder bar by cranks and a link.

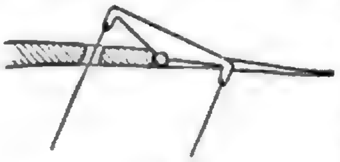


Fig. 23

Personnel—Seats are provided for a crew of four, who are carried as follows: one in the front cockpit; one in the pilot's seat; one at the pilot's side, and one in the rear cockpit.

All can, if necessary, change places while the machine is in the air. Between the front cockpit and that of the pilot a sliding panel is provided through which the gunner can crawl. The seat at the side of the pilot folds up and slides back into a cavity under the coaming of the nacelle and when in this position allows access down a narrow and inclined passageway to the rear cockpit. The machine can hardly have been designed to satisfy the requirements of the average pilot in regard to view, as from the pilot's seat it is very difficult to see the ground properly on account of the position of the lower main plane and the width of the body.

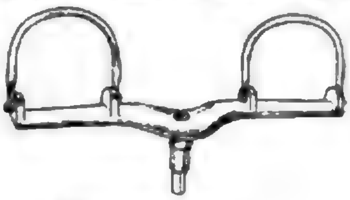


Fig. 24

Armament—Two Parabellum guns are mounted, one in the front cockpit and one in the rear, and provision is made for mounting a third or for transferring one of the others on the floor of the rear cockpit, so that it can fire backwards and under the tail of the machine. For this purpose a large trap door, which is shown in Fig. 25, is provided in the floor of the body behind the rear cockpit. This trap door has celluloid windows and is normally kept closed by springs. It is lifted up by a small hand winch fitted with a ratchet. It is of passing interest to note that whereas in the Friedrichshafen a similar trap door was kept open by means of springs, in the A.E.G. springs are used to keep the door closed. In the front cockpit the gun is supported on a carriage which runs round a partially circular rail which is strongly supported from the body by a framework of steel tubes. Forming part of this frame is an inclined steel tubular column, the base of which is fitted in a swivel bearing in the floor of the cockpit, and on this is mounted an adjustable seat for the gunner. A toothed rack runs round the rail and engages with a spur pinion driven by a hand wheel so that the gunner, when occupying his seat, swivels himself round as well as the gun. This gun mounting is shown in Fig. 26, and a diagrammatic section of the carriage is given in Fig. 27. The vertical swivel of the fork-ended gun carrier is locked by a ball-ended lever and a similar lever is employed for locking the carriage itself to its rail.

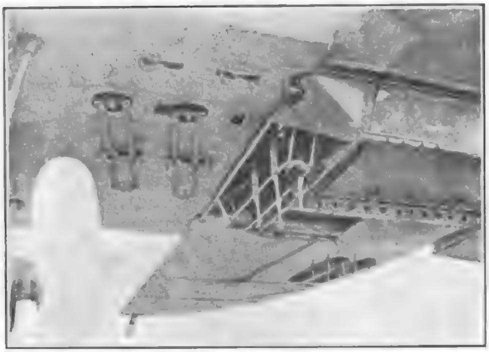


Fig. 25 Underside of the Nacelle Showing Bomb Magazine and Racks; Also Trap Door in Rear Cockpit

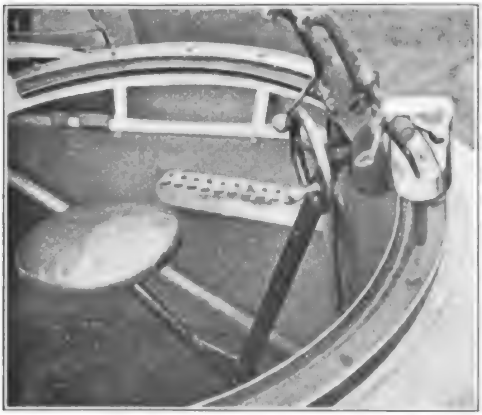


Fig. 26 Front Cockpit and Gun Mount

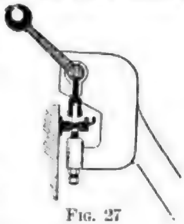


Fig. 27

This action is accomplished by a cam device which depresses the roller of the carriage and squeezes the rail section between the roller and an adjustable set screw which normally just clears the groove on the under side of the rail. In order to prevent the forward gunner from shooting the tractor screws, preventative shields of light steel tube are carried between the upper edge of the forward cockpit and the inclined struts of the center section. These impose a limit to the travel of the gun. In the rear cockpit the gun mounting is U shaped in plan form, and here again the principle of a carriage running on a rail and driven by a spur gear meshing with a toothed rack is employed, though in this case the gunner's seat does not revolve with the gun (Fig. 28). The carriage is of a somewhat similar type to that used in the front cockpit, but the method of locking it is different. This is shown diagrammatically in Fig. 29. The rail is provided with grooves both above and below, there being two rollers at the top and one underneath. Normally, when the gun carriage is free, the latter is clear of the rail, but when the locking mechanism is brought into action it is forced upwards so that the rail is gripped between the rollers, thus avoiding any possibility of shake at this point, and at the same time a positive lock is obtained on a second rail carried below the first. When the ball-ended hand lever is tightened, its effect is to squeeze the lower rail between two jaws. The movable jaw is, however, connected up by a link to a small cam, the base of which abuts against the foot of a fork-ended rod which carries the lower roller and is free to move up and down in a guide, to the base of which the cam is pivoted. By this means a very secure and rapid locking device is obtained. In the front of the rear cockpit a locker is provided which would be capable of holding ammunition, and beneath this a series of racks of the type shown in Fig. 30. These racks are not strong enough to hold anything very heavy, and are placed approximately 5 in. apart. Their exact purpose is not known.

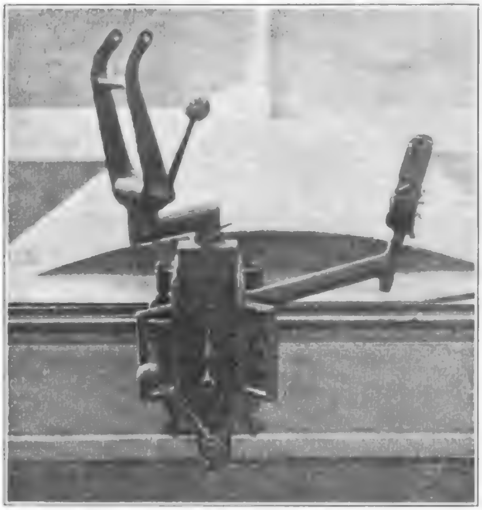


Fig. 28 Gun Mounting in Rear Cockpit

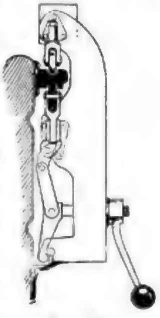
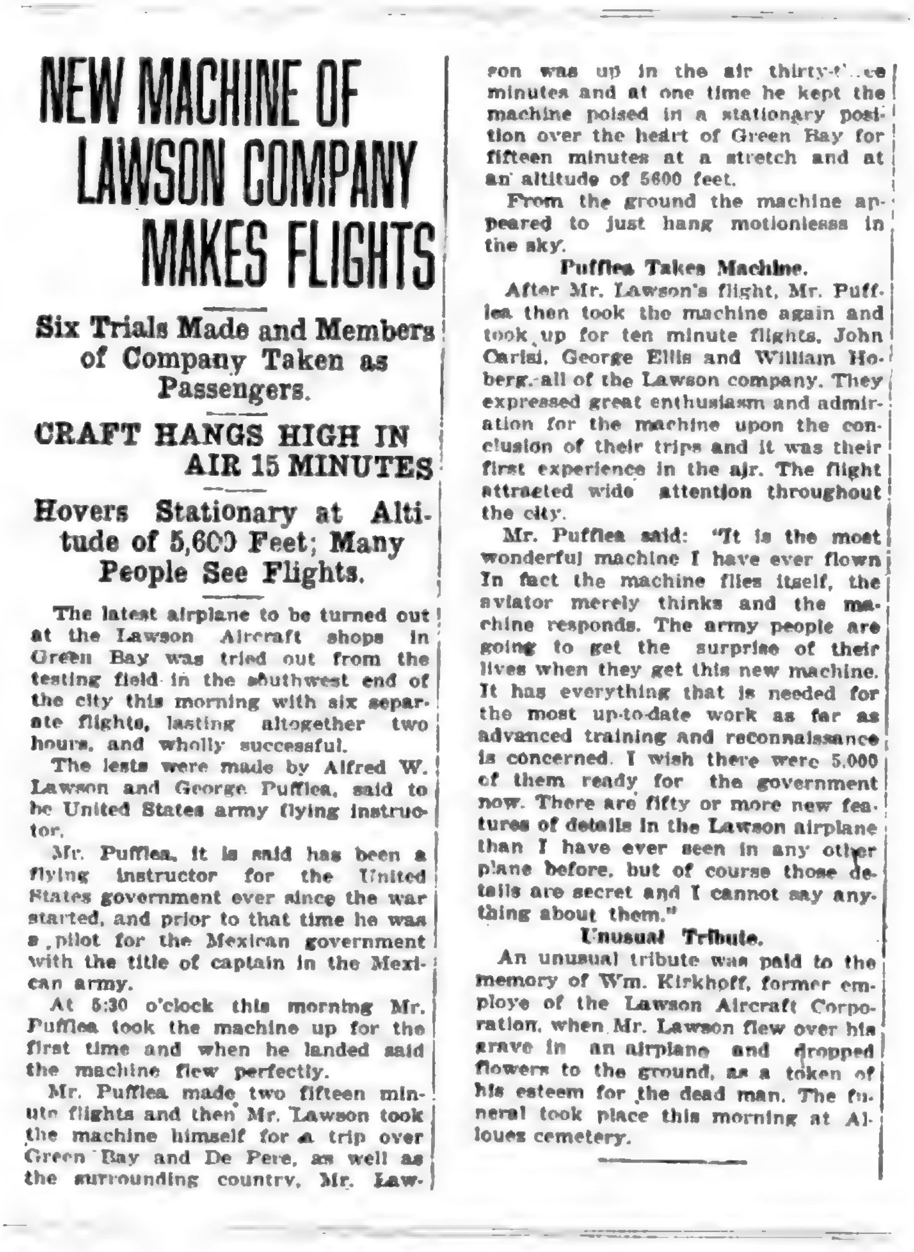


Fig. 29

Bombing Gear — Three racks for holding twenty-five pounder bombs are installed on the machine; two side by side on the left side of the rear cockpit, and one on the right side of the fuel tanks in the space between the pilot's and rear cockpits. This rack is covered by a detachable wooden lid which acts as the floor of the narrow gangway mentioned above. Underneath the center of the nacelle provision is made for carrying two or more large bomb racks, which, however, were not in

From Green Bay Press-Gazette

May 2nd, 1918



NEW MACHINE OF LAWSON COMPANY MAKES FLIGHTS

Six Trials Made and Members of Company Taken as Passengers.

CRAFT HANGS HIGH IN AIR 15 MINUTES

Hovers Stationary at Altitude of 5,600 Feet; Many People See Flights.

The latest airplane to be turned out at the Lawson Aircraft shops in Green Bay was tried out from the testing field in the southwest end of the city this morning with six separate flights, lasting altogether two hours, and wholly successful.

The tests were made by Alfred W. Lawson and George Pufflea, said to be United States army flying instructor.

Mr. Pufflea, it is said has been a flying instructor for the United States government ever since the war started, and prior to that time he was a pilot for the Mexican government with the title of captain in the Mexican army.

At 5:30 o'clock this morning Mr. Pufflea took the machine up for the first time and when he landed said the machine flew perfectly.

Mr. Pufflea made two fifteen minute flights and then Mr. Lawson took the machine himself for a trip over Green Bay and De Pere, as well as the surrounding country. Mr. Lawson was up in the air thirty-three minutes and at one time he kept the machine poised in a stationary position over the heart of Green Bay for fifteen minutes at a stretch and at an altitude of 5600 feet.

From the ground the machine appeared to just hang motionless in the sky.

Pufflea Takes Machine.

After Mr. Lawson's flight, Mr. Pufflea then took the machine again and took up for ten minute flights, John Carisi, George Ellis and William Hoberg, all of the Lawson company. They expressed great enthusiasm and admiration for the machine upon the conclusion of their trips and it was their first experience in the air. The flight attracted wide attention throughout the city.

Mr. Pufflea said: "It is the most wonderful machine I have ever flown In fact the machine flies itself, the aviator merely thinks and the machine responds. The army people are going to get the surprise of their lives when they get this new machine. It has everything that is needed for the most up-to-date work as far as advanced training and reconnaissance is concerned. I wish there were 5,000 of them ready for the government now. There are fifty or more new features of details in the Lawson airplane than I have ever seen in any other plane before, but of course those details are secret and I cannot say anything about them."

Unusual Tribute.

An unusual tribute was paid to the memory of Wm. Kirkhoff, former employe of the Lawson Aircraft Corporation, when Mr. Lawson flew over his grave in an airplane and dropped flowers to the ground, as a token of his esteem for the dead man. The funeral took place this morning at Allouez cemetery.

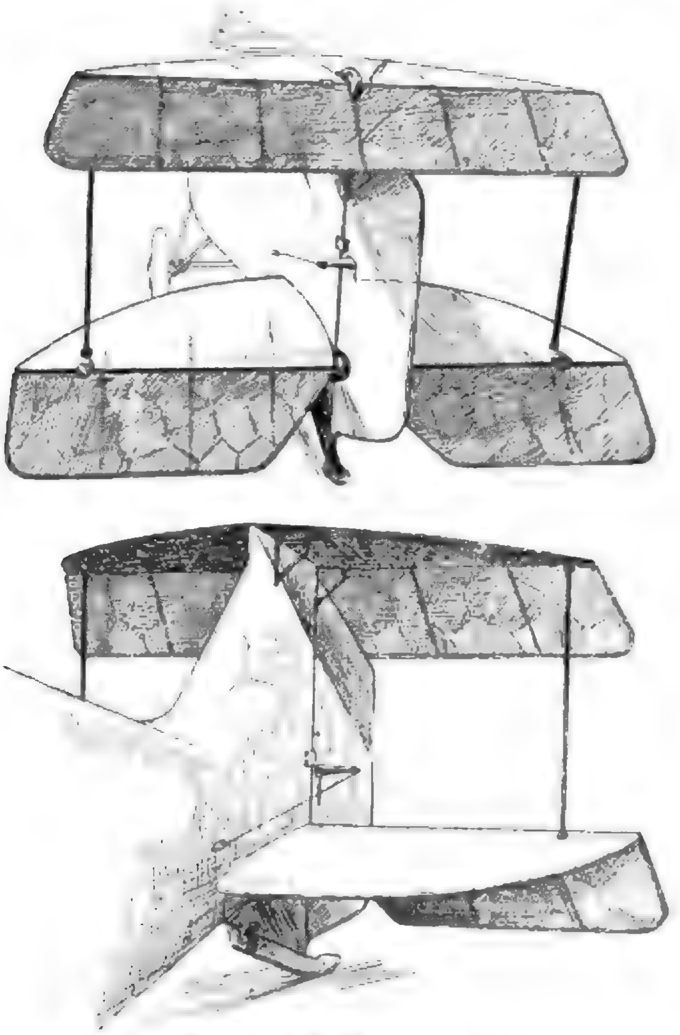
THE PERFORMANCE

LAWSON,
GREEN BAY, WIS.

airplanes. Germany, having made thousands of tests in the structure of Scotch pine growing in various of her forests, was able instantly to secure rich supplies of wood of exactly the quality required for airplanes. Dealing with the fireproofing of woods, the speaker said investigations had rendered it possible to such an extent that thin 3-ply wood could be made to resist for minutes, or even hours, a temperature of 3000 deg. F. The process of fireproofing was not, however, cheap.

Flight, May 30, 1918

*Constructional Details of the Hannover Biplane.**—Constructionally the body of the Hannover biplane is that now so frequently found on German machines, a light framework covered with three-ply. In section, however, the body is somewhat unusual, in that at the point of maximum depth it has flat sides and bottom, with a curved deck, while near the nose the section is nearly circular and the tail portion is oval in section, not unlike the tail of a fish. This seems rather the reverse of usual practice.



Two Views of the Tail Planes

In the gunner's cockpit there is the usual hinged seat which can be swung back out of the way when the gunner wishes to fire from a standing position. On the port wall of the body there is a wood drum around which the aerial is wound, passing through a wide tube fitting in holes in the bottom of the body. Centraly placed, in front of the gunner's feet, is a framework of steel, which appears to have been used for releasing the bombs, under which there is a sliding trap door in the floor, which reveals, when removed, another compartment underneath the floor boards, which is also fitted with sliding trap door. The latter is operated by a rather clumsy arrangement of cables and pulleys; when both doors are open the way is clear for the bombs to drop. The bombs were apparently carried in racks on the floor to the right of the release gear, while on the left a number of fittings appear to indicate that here was at one time mounted the wireless set. On the starboard wall of the body is a lever which has probably been used for throwing the wireless into and out of gear. No gun was mounted on the machine examined, but the gun ring and pivot were of the usual type.

The motive power was furnished by an Argus engine partly covered in, each three cylinders of which had a common exhaust collector projecting out past the struts of the starboard "N" carrying the top plane center section.

As regards the biplane tail planes, the arrangement of these will be easily grasped from the accompanying illustrations. In design they do not appear to present anything very unusual, and the only point of interest appears to be that although the two fixed planes are connected by struts there is no wire bracing. Each plane is thereby to be considered a simple cantilever, and as their section does not appear to be very deep, the strength would not appear to be all that it might.

Flying (London), June 12, 1918

The Pfalz Pursuit Biplane.—Following official tests made by the British authorities, the Pfalz pursuit biplane is credited with the following performances, which are by the way generally inferior to those of the Albatros D-III.:

Speed at 10,000 ft., 102½ m.p.h.; 1400 revs.
Speed at 15,000 ft., 91½ m.p.h.; 1325 revs.
Climb to 10,000 ft., 17 mins., 30 secs.
15,000 ft., 41 mins., 20 secs.
Estimated absolute ceiling, 17,000 ft.
Total weight of machine fully loaded, 2056 lbs.
Weight of machine bare, with water, 1580 lbs.
Military load { Pilot, 180 lbs.
Two Spandau guns, 70 lbs.
Dead weight, 31 lbs.
Gasoline, 21½ gal.
Oil, 4 gal.
Area of main planes, 240 sq. ft.
Weight per sq. ft., 8.56 lbs
Weight per h.p., 12.84 lbs.

The Aeronautical Journal, April, 1918

Computation of Aerodynamic Support. By W. R. D. Shaw.—The function of an aerofoil of circular arc camber is to impart motion in a circular path to a mass of air whose volume is determined by the product of span, chord, and mean sweep, the latter being a linear measure of the depth of the strata of air affected above and below the surface.

Notations employed:

Total pressure on aerofoil, lbs. wt.	P
Flight velocity, ft. per sec.	V
Chord dimension, ft.	y
Maximum camber, ft.	c
Radius of curvature, ft.	r
Span, ft.	m
Mean sweep, ft.	d
Density of air, lb. per cu. ft.	p
Acceleration due to gravity, ft. per sec. per sec.	g

By the Theorem of Pythagoras

$$r = \frac{y^2 + 4c^2}{8c} \qquad (1)$$

In practice the sweep factor or mean sweep varies from 0.8 to 1.2 times the chord dimension. Taking the average value

$$d = y \qquad (2)$$

The volume of air continually in dynamic contact with the aerofoil is in cubic feet from (2)

$$my^2 \qquad (3)$$

The weight of the volume of air (3) in pounds is

$$pmy^2 \qquad (4)$$

Taking p as .08 lb. per cu. ft. and g as 32.2 ft. per sec. per sec., the total air pressure, which in effect is the centrifugal reaction of the air on the curvilinear surface, is given by the expression

$$P = \frac{.0194\, my^2V^2c}{y^2 + 4c^2} \qquad (5)$$

Aeronautical Patents

ISSUED JUNE 4, 1918

1,268,383—To Frithrof Gustof Erleson, Toronto, Ont., Canada. Landing gear construction of airplanes.
1,268,494—To August C. Rutzen, Cleveland, Ohio. Airship.
1,268,710—To James T. Gregory, Washington, D. C. Airplane safety device.
1,268,779—To Charles L. Hudler, St. Louis, Mo. Hydroaeroplane.

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* See also last issue of Aviation and Aeronautical Engineering.

News of the Fortnight

Senate Approves Aircraft Corporation

The creation of a $100,000,000 aircraft production corporation was approved by the Senate June 28. The action was taken without debate. There was not a dissenting vote. As adopted by the Senate the Director of Aircraft Production is empowered in his discretion to form the aircraft production corporation with a capital of $100,000,000. The director must subscribe and vote not less than a majority of the stock. The corporation must be dissolved within one year following a treaty of peace with the Imperial German Government. The Secretary of War is given authority to assign all men needed for making the corporation operative.

The power conferred on the Director of Aircraft Production gives him the right to "form one or more corporations for the purchase, production, manufacture and sale of aircraft, aircraft equipment or materials therefor, and to build, own and operate railroads in connection therewith."

The Aircraft Production Corporation closely follows the lines of legislation creating the Emergency Fleet Corporation, the War Finance Corporation and other organizations under which the Government is handling certain lines of industry connected with efficient prosecution of the war.

Air Service—The New Name

Official documents coming through the War Department during the past week have indicated that a new name for the new air organization has been adopted by the General Staff.

At present the plan is to make "Air Service" the official title of a branch of the National Army, and to commission officers, enlist men and civilians therein, attaching them to either the Department of Military Aeronautics, or the Division of Aircraft Production, which were created by the Presidential order separating the service from the Signal Corps, according to their respective requirements.

The plan also embraces the detail to the Air Service of officers already commissioned in the Aviation Section of the Signal Corps, Signal Reserve Corps, and Signal Officers' Reserve Corps, yet leaving enough men in the Aviation Section in the Signal Corps in order to keep it intact as an organization.

Trial Flight of American Caproni

The trial flight of the first American-built multi-engined bombing airplane, a Caproni biplane fitted with Liberty engines, successfully took place on Independence Day.

The machine was built in the Elizabeth plant of the Standard Aircraft Corp., which concern may be justly proud of the unqualified success that attended the first taking the air of the first American-built airplane of capital size.

The trial flight of the three-engined Caproni biplane took place at Hazelhurst Field in the presence of John D. Ryan, Director of the Aircraft Production Bureau; W. C. Potter, a member of the Aircraft Board, and a number of American and Allied aviators. The flight was successful in every way.

The machine was in charge of Lieut. Gianfelice Gino, a pupil of the late Captain Resnati, and carried three Italian officers as passengers. For fully an hour the big machine maneuvered above the group of watchers, and then Lieutenant Gino glided down to a perfect landing.

Screw Thread Commission

The conference committee of the Senate and House reached an agreement on July 2 on the House Bill 10,852, providing for the appointment of a commission to standardize screw threads. The bill was amended limiting the life of the commission to six months and passed.

New Company to Operate Air Lines

The Swift Aircraft Manufacturing Co., of Camden, N. J., has been incorporated, and will operate aerial lines between Chicago, Boston, Philadelphia, Washington, New York and other cities, according to papers filed with Secretary of State Martin. The papers stipulate that the airplanes, which are to be manufactured by the concern will carry mail and merchandise and will be built at plants to be erected in various parts of the country.

Aerial Independence Day Parade

The celebration of Independence Day was rendered memorable for New Yorkers by an aerial parade consisting of a large formation of airplanes and a naval airship which flew over the city during the ground parade, scattering thousands of copies of the "Star Spangled Banner."

Among the machines which participated in this aerial parade were 6 American combat machines, 21 training planes, a Caproni bomber, and a Spad pursuit plane.

Mailplane Postage Is Decreased

An anticipated announcement of a reduction in the rate of mailplane postage was made by the Post Office Department on June 29. The new rates will be 16 cents for the first ounce and 6 cents for each additional ounce or fraction of an ounce. This is a decrease of 8 cents for the first ounce and of 18 cents for the second ounce from the initial rate of 24 cents per ounce, or fraction regardless of weight.

Its purpose is to increase the patronage of the aerial mail service. If it succeeds both the Government and the public will be the gainers—the amount of mail carried per trip would be boosted nearer to airplane capacity without increasing the cost of transportation and the average revenue to the Department on a letter weighing 2 oz. would be only 2 cents less than that under the present 1-oz. rate, while the decreased cost to the public for a 2-oz. letter would be 24 cents. In other words, a 2-oz. letter under the new rates may be mailed at the price of a 1-oz. letter under current rates. The new rate becomes effective beginning July 15.

Skilled Workmen May Be Furloughed

The determination of the Director of Aircraft Production to see that airplanes are built in quantity is indicated in a set of papers sent to all aircraft manufacturers in the United States.

It is announced that the Government intends to assist contractors in meeting their labor problems. By filling out prescribed forms the Director of Aircraft Production says that indefinite furloughs can probably be obtained for any skilled or technical employes heretofore drafted.

After the draft or enlistment of any skilled employe the manufacturer or contractor may fill out certain fixed forms, and, after the man reports to the camp or recruit depot to which he has been assigned, he may be granted an indefinite furlough without pay or allowances and ordered to report to his former employer. This furlough will continue as long as the man retains his employment. He may wear the uniform or wear civilian clothing, as he chooses.

Blanks may be obtained from the Director of Aircraft Production, Washington, D. C.

N. A. C. for Aeronautics Moves

The National Advisory Committee for Aeronautics announces the removal of its headquarters from the Munsey building, Washington, D. C., to the Aircraft Administration building, Missouri avenue between Fourth and Sixth streets, Northwest, known as building "D." Its offices will be located on the second floor of the fourth wing in rooms adjoining the Aircraft Board.

All parties concerned in addressing mail or other matter to the committee are requested to use the following form:

National Advisory Committee for Aeronautics, Building "D," fourth wing, second floor, Fourth and Missouri avenue, N. W., Washington, D. C.

Airplane Walnut Supply

As a result of the President's call made upon the Boy Scouts of America three or four weeks ago to make a systematic search for black walnut for use in manufacturing airplane propellers, etc., it is stated they have met with such success that millions of feet have been located, or enough to meet the needs of the Government for months to come.

Admiral Sims on the Liberty Engine

The Secretary of the Navy has authorized the following statement on July 2:

"Secretary Daniels today received a dispatch from Vice Admiral Sims stating that the recent tests of a seaplane equipped with the Liberty engine resulted in better performance as regards climbing and load-carrying than similar airplanes equipped with one of the best types of European engines. Admiral Sims says: 'The British expressed great confidence in the Liberty motor.'"

Curtiss Square Deal Department

The Curtiss Aeroplane & Motor Corp. has taken a long stride forward in the development of industrial morale by the establishment of a Square Deal department in the Division of Education and Welfare.

The Square Deal department is for the benefit of all Curtiss employes, whether in factory or office. Its purpose is to apply the square deal to all employes and to the company itself, by removing the causes of any dissatisfaction that may arise and by placing employes in the positions for which they are best fitted.

Any employe who feels that he or she has been unjustly dismissed, overlooked in promotions, assigned to duties for which they are not best fitted, neglected in wage advances or made the victim, real or imagined, of favoritism by foreman or superintendent may bring complaint to the Square Deal department. An investigation is made immediately.

Rebreathing Machine for Aviators

By a "rebreathing machine," the first of its kind to be established by the United States Government or any of its Allies, American aviators henceforth will be classified according to their ability to thrive in high altitudes.

The machine is in a research laboratory at Barron Field and is in charge of Lieut. G. H. Hanson, W. W. Thomas and James Blair, who arrived in Fort Worth recently from Mineola, N. Y. It produces all the sensations of ascending and descending and has been in use by the German air service, it is said, for five years.

Henceforth no pilot from any of the Army fields will be assigned to active duty overseas until he has passed the tests of the contrivance and been classified according to his ability to withstand altitude fatigue. Experience has taught that many air casualties are due to this fatigue. One man will be so affected that he will faint. Another will go along with his flying mechanically and with his mind so dulled that he cannot plan or execute an attack on an enemy. Still another will become stupid and his nerves will not react to the excitement of battle.

The pilots will be divided into three classes. In the first class will be placed airmen who are never affected by altitude fatigue and who can ascend and fight anywhere their planes will mount.

In the next class will be those whose mental faculties are dulled by high altitude.

And in the last, or third, will be those who faint under the stress.

Doehler to Build Addition

Ground has been broken for the new addition to the Doehler Die-Casting Co.'s Brooklyn factory on Court and Huntington streets. This addition will cover 150 ft. on Court street and 200 ft. on Huntington street, and will be ten stories high, actually doubling the present capacity of the plant.

Construction will be of steel and concrete throughout, to conform to the general character of their present structures.

Newly perfected types of automatic die-casting machinery are now in process of construction, ready to be installed in the new building, which is to be ready for occupancy before the summer is over

Contract for F5 Surfaces

Curtiss Aeroplane Motors, Ltd., Toronto, Canada, has been awarded a contract for F5 surfaces by the Bureau of Supplies and Accounts of the Navy.

Statement on Aircraft Production

At the suggestion of Representative S. Hubert Dent, Jr., chairman of the House Committee on Military Affairs, the Secretary of War under date of June 28 made a written statement in regard to the progress of various military activities.

Under the head of aircraft production, including training planes, bombing planes, combat planes and guns therefor, and production of Liberty engines, Secretary Baker gives the following figures:

"Deliveries of elementary training planes to June 8, 4495; deliveries of advanced training planes to June 8, 820.

"The average weekly production of advanced training planes during April was 22; during May was 45½; week ending June 8 was 78.

"To June 8, 286 combat planes were delivered. The weekly average of this type of machine in April was 5; in May, 38; and for the week ending June 8 was 80.

"Six thousand eight hundred and eighty elementary training engines were delivered to June 8; 2133 advanced training engines were delivered to same date.

"More than 2000 Liberty engines have now been delivered to the Army and the Navy. The average weekly production in April was 96, in May 143, and in the first week of June 115.

"Thirty-seven thousand two hundred and fifty machine guns were delivered for use on airplanes before June 8."

Maximum Fir Prices

Following a conference with the loggers and lumber manufacturers of the Pacific Northwest the Price Fixing Committee of the War Industries Board has established the following maximum prices for a period of ninety days from June 15:

Fir logs delivered at customary points to sawmill operators: No. 1, $20 per thousand; No. 2, $16, and No. 3, $12 for 40-ft. lengths; over 40 ft., price to be on same basis as established by custom or as decided by the Lumber Section of the Board.

Prices of fir lumber for aircraft use are to remain the same as now.

These prices represent an average increase of approximately $2.75 per 1000 board feet over former prices to the Government and are f.o.b. mill.

Contracts are to be made always subject to an option by the Government, under which option supplies will be allocated either to the Government or to other essential users to any extent required.

Du Pont Gives Y. M. C. A. Airplane

Irenee Du Pont, head of the Du Pont interests at Wilmington, Del., has presented to the School for Airplane Mechanics, conducted by West Side Y. M. C. A., of 318 West Fifty-seventh street, New York City, a complete airplane, which is to be brought here for the use of the school. F. F. Tenney, principal, and W. D. Davis, instructor, have gone to Claymont, Del., to inspect the gift and bring it here, in the air if practicable, to save transportation. The plane is a Curtiss J. N.-4 military tractor biplane. Mr. Du Pont's letter announcing the gift says among other things: "We have concluded, in view of the national importance of your school, that we will make a donation of the machine to you."

The School for Airplane Mechanics has grown so rapidly since it was opened last fall that it has been necessary to rent additional quarters. Part of the building at 240 West Fifty-third street has been in use from the beginning and is in operation from 8 a. m. till 11 p. m. daily except Sunday. In June 221 students were enrolled, a total of 921 for the seven months. The new quarters are at 239 West Fifty-sixth street. The plane instruction will be given here, the old school being devoted to engine work.

Anglo-Norwegian Air Mail Planned

The submarine warfare has made the sea mails so irregular across the North Sea that the scheme for an airplane service is being energetically pushed forward by a Norwegian company with the backing of the Norwegian Government. The journey across the North Sea has already been made in five hours, and it is estimated that, in a regular service, the ordinary average time would be under 4½ hr.

The British Government, while it has no airplanes to spare for such purposes in war time, is prepared to give the Norwegian company every facility.

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